Science Education

DO SCIENCE RADIO BROADCASTS PAY? *

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For six years science lessons have been broadcast in the Rochester School of the Air, over Station WHAM, Rochester, New York. During this time, many thousands of children in schools not only in Rochester, but in western New York, northern New York, and Canada have listened. Nearly two thousand children have participated in the broadcasts. Hundreds of teachers have had their science work directed in part, at least, by the radio. Station WHAM has contributed thousands of dollars of radio time, the Rochester Board of Education has spent generously to provide teacher service, so the question may properly be asked, "Does it pay?" This can be answered not in terms of dollars and cents, but in terms of effects on the teacher and pupils. That pupils are profoundly affected has been reported in previous articles [1] by the writer. This account is the first based upon teacher comments.

At the present time, science lessons are being broadcast for fifth, sixth, seventh, and eighth grade classes, including a known total of 18,543 pupils. How many unreported classes are listening is not known. Outside of Rochester there are 149 fifth-grade classes registering nearly 2500 pupils, 167 sixth-grade classes registering over 2500 boys and girls, 118 seventh-grade classes, totaling over 2000 children, and 100 eighth-grade classes containing nearly 2000 children. Thus the teachers of more than five hundred classes distributed in nearly 200 schools outside of Rochester are affected in one way or another by the science radio broadcasts.

In the Rochester schools, the radio work is a part of the regular school program. On the other hand, schools outside of Rochester are voluntary listeners, many of which have been constant users of the radio programs during the entire six years. In order, therefore, to discover some facts relating to the advantages and disadvantages of the science radio lessons, a questionnaire of nine questions was sent to all teachers (168) known or thought to be using the science radio programs. A summary of data obtained from these questions follows.

One hundred twenty five of the one hundred sixty eight questionnaires mailed were filled out by teachers and returned. Seventy-six per cent of these report that their children, as a group, are much interested in the science work. Eighteen per cent report that the children are somewhat interested in the science work, and only two per cent report no interest at all.

From a study of the teachers' reports, it appears that the radio science has increased pupil interest in science. Some schools are determined to increase their science equipment another year. Country schools, particularly, report that science is important because it is so tangible in

*Presented before the Science Section of the World Federation of Education Associations, on board the S.S. Rotterdam, August 16, 1939.

[1] "Teaching Science by Radio." *The School Executive,* January, 1938.
"Teaching Science by Radio." *Junior-Senior High School Clearing House* 8:421–427; March, 1934.
"Writing Scripts for Children; Class Programs, Seventh Grade Science." In *Education on the Air,* Seventh Yearbook of the Institute for Education by Radio. Columbus: Ohio State University, 1936.
"Science in the Rochester School of the Air." *Science Education* 21:77–81; April, 1937.

their environments. The following statements further reflect opinions of reporting teachers:

"Experimental and activity work enliven the interest." "Children are always anxious to do their science." "A science textbook means more after the radio." "Evidently a good deal of science has been taught as book science. The radio has relieved this situation." The Science Discovery Table, containing specimens brought in by various pupils for study, reflects their interest."

Following are quoted some of the actual statements made by teachers in answer to the question, "Are the children as a group interested in their science?":

"Much. Experiments and activity work connected with class discussion greatly enlivens interest."

"They are always anxious to do their science and mail the best and poorest papers to you."

"Nearly all of the classes look forward to Thursday afternoon."

"The children tell of many observations made on the way to school. Often this is the result of suggestions made by the science programs."

"In some cases children who have remained at home because of illness have listened to radio at home and reported on it when they have returned."

During the broadcasts experiments and observational work relating to the science program are described, and children are asked to carry out these experiments in school and at home. It should be mentioned that practically none of these schools are adequately or even passibly equipped for science instruction. In fact, most of them have no science equipment at all. Therefore, experiments must be such that ordinary equipment found in the home can be utilized. According to the reports of the teachers, 91 per cent of the children enjoy doing the experiments and observational work; 30 per cent perform many experiments at home; 60 per cent do some experiments and observational work outside of school, and only 3 per cent do none.

Comments by teachers on the question, "Do children enjoy the experiments and observation work?" include:

"Yes, these arouse interest and encourage thinking."

"This is apparently the greatest motivator. Class discussion will go on almost indefinitely on such topics as actual experiences with bird life, etc."

"Yes. I think the children as a whole enjoy the experiments more than the observational work."

"Yes. They would enjoy even more experiments than I'm able to give them because of lack of equipment."

"The children always work the experiments in school and many work them at home for their parents. Children of the other grades enjoy listening to the other grade broadcasts."

"Much. They are becoming more observant, and we are breaking down superstitions that take root so easily in rural communities. Their reasoning power is growing."

In order to determine the extent, if any, to which schools included science because of the radio opportunity and to what extent science would be continued if the radio work were discontinued, the following question was asked, "Did you include science in these grades previous to the use of the radio?" According to the reports, 65 per cent of the fifth, 72 per cent of the sixth, 45 per cent of the seventh, and 38 per cent of the eighth grades were taught science previous to the radio. Comparing these figures with the fact that all the grades are now "taking" science, it is evident that the radio resulted in a very substantial increase in the number of grades receiving science instruction.

A second question was: "Would you probably continue the science work if the radio lessons were discontinued?" Answers were as follows: 75 per cent of the teachers of the fifth grade, 74 per cent of the sixth grade, 50 per cent of the seventh grade, and 41 per cent of the eighth grade reported that they would continue their science work. The conclusion might be drawn by comparing the two sets of data that because of the radio the teachers either approve of science more than they did previous to the radio, or they feel more confidence in teaching it because there is a substantial gain in the number who would continue the teaching of science even without the radio over those teaching it previ-

ous to the radio. Only 3 to 11 per cent of the teachers in the various grades reported that they would not continue the teaching of science. But let us get the words of the teachers themselves in regard to these two problems. They report as follows on the question, "Did you include science in other grades previous to the use of the radio?":

"My lessons did not cover nearly as much material as do your programs. I could not get near as many important items in my lessons. They were more general in nature."

"Some work was done, but not as much as has been done since we have listened to the radio broadcasts."

"Not very much—only book work and one or two field trips—one in fall—one in spring—and having a flower garden, etc."

"The rural teacher is limited by time both in the preparation of and the carrying out of science lessons. Therefore, only a small amount of time was spent on science previous to the use of the radio. The radio affords the teacher more time in such work."

"Before we earned our radio by selling seeds, I found science very hard to teach. We had no books for the children, and I am afraid science was uninteresting. Since we have the radio, thanks to your lessons there has been no such trouble."

"Yes, we have always had science in our schools, but not as thoroughly nor as often."

"We have taught science mostly by textbooks for four or five years."

"Only used science readers."

And in answer to the question, "Would you probably continue the science work if the radio lessons were discontinued?", they report:

"My children are too interested in science to give it up. In fact, even now we have a science period of twenty minutes each week besides the radio lesson."

"We should feel it a great loss to have the lessons discontinued. The work has correlated very nicely with social studies."

"I am sure the work would continue, even though no special time were allotted because the children's questions and observations would demand attention."

"I would continue the science work, but it would be much harder. The radio lesson gives us a start from which our discussions begin."

"Science is too valuable to discontinue."

"Although we probably would continue the science work, I think the radio lessons help to make the work more enjoyable."

"I would continue science without the radio lessons as I believe it to be an essential part of education, but I think that radio peps up a lesson and makes for pupil interest."

Again, in order to determine to some extent the influence of the radio as a teaching aid, this question was asked, "If the science work were to be continued without the radio, would you feel handicapped in any way?" Eighty-seven per cent of the teachers replied in the affirmative. Nine per cent stated they would not feel handicapped only four per cent failed to answer.

It will be interesting to give quotations from a few teachers in answer to this question:

"It would involve a great deal more planning. I have eight grades, and it is very difficult to plan for eight grades and all subjects."

"I would be handicapped without radio lessons. The radio aids in the teaching of science by making the plans for the year, thus relieving the teacher of making detailed plans. The material provided is helpful, and the ideas of the specialist (broadcaster) serve in the same manner as the help of a science supervisor which we do not have."

"I would be very much handicapped because I am not familiar enough with science work."

"They help very much in a rural school where a teacher has so many grades that she does not always find time to prepare lessons for this particular subject."

"The radio lessons have helped me a great deal in the teaching of science. I would feel handicapped without them, but think I would be able to carry out a better program than I would if we hadn't had the radio lessons at all."

"The radio brings an outside teacher into the classroom which in the one-teacher school, breaks up the monotony of one teacher. It brings to the children the work of other schools and pupils in science."

"Yes, I would. It would be almost impossible for me to cover the amount of work that we have had."

"It aids me in that it gives me much time. The time which I formerly used in making my outlines, etc. can be spent in preparing the real facts and in assisting the children to carry out the work which is outlined on the radio."

"I feel that the radio is more of an incentive and inspiration than a presenter of special material. I feel that it adds zest and enthusiasm to the science classes."

"It offers pupils in rural sections the thrill of membership in a wide circle of young scientists. My pupils would feel lost."

Radio is able to bring new personalities into the classroom. It provides interesting information and directs the training of the boys and girls in the classroom in many ways. These statements, I think, may be inferred from some of the foregoing teachers' reports. Another possible function of radio is its value as an aid to the training of teachers in service. To secure comments on this problem, the following question was asked, "It has been said that radio lessons may be an aid to the training of teachers in service. Specifically, do you think that the radio lessons in science have contributed in this respect?"

One hundred three teachers, that is, 82 per cent of the number reporting, replied in the affirmative. Two teachers replied negatively. Only 16 per cent did not answer the question. Teacher opinion is indicated by the following quotations:

"Yes, very much. In furnishing background, model lesson plans and stimulating interest in the subject."

"Methods of presentation used by radio instructors are valuable for grade teachers, many of whom have had little practice in science."

"Yes. Most elementary teachers have only a minimum of scientific knowledge and the average teacher has very little interest, perhaps because of lack of knowledge. Thus, an uninterested teacher can have little hope of inspiring children or of being helpful to children who are naturally science minded. I find that I, as a teacher, learn more than the child from each lesson. And with the knowledge a better idea of how to teach science."

"Listening to good enunciation, formulation of questions, etc., are always good for teachers in service."

"Yes. I think that poor as well as good teachers can and do profit from the type of teaching to which they are submitted by radio lessons. It has some of the benefits of teachers observing others. It offers inspiration."

"Yes—training in logical and also psychological approaches to treatment of science subject matter."

"It opens up new thoughts and avenues of introductions and approaches to various lessons that we sometimes fail to add to our years of service, especially when one wishes to get the most out of teaching that he can."

"Yes. The radio lessons have helped me very much in making better science plans and thereby making better lessons."

"It gives teachers new ideas in presenting material and arousing interest in the children."

"It creates new interest in other beauties and marvels of nature and life. We are aware of many of these things, but the ever astonishing variations of science in all its aspects make the humdrum 3 r's of teaching more interesting."

"Yes—especially in method of presentation. An emphasis on scientific thinking."

Because of a great many letters from adults, including parents of children, from many word-of-mouth indications of adults listening, it would seem that the Rochester School of the Air has a wide adult listening audience. On the other hand, we have no accurate data.

The child in the classroom who receives instruction by radio has at least two teachers and possibly three. One teacher is the radio broadcaster who presents the science material in what may be called a "teaching talk." During the broadcast, the classroom teacher listens with the children. She is aided in many ways as indicated above. Following the broadcast, this teacher is able to carry on effectively with the children. If she is observant, she knows those children who have been listening attentively and those who have not. By judicious questioning, the pupils making use of brief notes which they have made, the important points of the radio lesson may be further developed and emphasized. Laboratory work may be carried out. Children may be assigned to various types of duties relating to the science work of the group as a whole. In many ways this listening teacher may do more effective work than without the aid of the radio.

The third possible teacher is the parent or other adult in the home. Listening to the broadcasts, these parents are able to discuss with the child this part of his schooling more intelligently than is possible without the aid of the radio. Education has changed rapidly in a generation, and about the only way the parent of the present may become really familiar with modern education as it is actually working

is by listening to programs of the School of the Air.

In order to secure some further evidence on this problem, the following question was asked, "To what extent, if any, do the parents of your children listen to the science radio lessons?" Answers to this question are not conclusive, but that parents do listen to a considerable extent may be inferred from teacher reports as follows:

"About twenty per cent listen."

"Thirty parents listen."

"Ten parents out of a class of twenty-eight children listen."

"Ten per cent listen."

"In a fifth grade of thirty-two pupils, ten parents listen. In a class of twenty-four sixth grade pupils, nine parents listen. Seven parents of a seventh grade containing twenty-three pupils listen, and eight parents of twenty-five eighth grade pupils."

Another teacher reports that twenty-five per cent listen; another twenty per cent; another twenty-five per cent. One teacher reports that ninety per cent listen occasionally, but not regularly.

Roughly, it would appear from these data that twenty to twenty-five per cent of the parents do listen to the broadcasts that are being heard by their children. If these figures are approximately true, then, the School of the Air is a powerful method for supplementing the education of the children and acquainting parents with the content and ideals of modern education.

While by far the greater proportion of replies indicate interest on the part of the children and the value of the radio programs to teachers, there are some adverse comments which should be reported. For example, one teacher reports as follows:

Question: "Are the children as a group interested in their science work?"

Answer: "Not at all. These children fairly writhe at the mention of the word science. It was because of this attitude that I wanted to try the radio program. We have been using .... series of texts."

Question: "Do the children perform some experiments at home and make outdoor observations?"

Answer: "Little. So much of the work is supposition that the children become discouraged and say, 'What's the use?' (For example, study of the planets.)"

Question: "Did you include science in these grades previous to the use of the radio?"

Answer: "Yes. Science is a required subject of the New York course of study."

Question: "Would you probably continue the science work if the radio lessons were discontinued?"

Answer: "As long as it is required. I have found during seven years of experience that 9 or even 10-year old girls are not interested in electricity, principles of magnetism, and the elements. They do understand things that live and grow. Why are things required that they can't comprehend?"

Question: "If the science work were to be continued without the radio, would you feel handicapped in any way? That is to say, to what extent do the radio lessons aid in the teaching of science in these different grades?"

Answer: "The radio teacher might use other examples than those used by the classroom teacher. I think they like to have another personality come into the room via radio."

Question: "It has been said that radio lessons may be an aid to the training of teachers in service. Specifically, do you think that the radio lessons in science have contributed in this respect? How?"

Answer: "Listening to good enunciation, formulation of questions, etc., are always good for teachers in service."

Below are grouped answers given by different teachers to the questions proposed.

Question: "Are the children as a group interested in their science work Much ...., Little ...., Not at all ...."

Answers:

"Little. We intend to increase our science apparatus for next year and feel that this concrete work supplemented with the broadcasts will increase the interest."

"Little. Being in a rural school, there is little time for supervised science study which is necessary for interest. We do a great deal of outdoor study."

"Little. Since I have such a small number, my opinion would be biased, but I feel the lessons would be more effective if a small amount of review questions were asked at each lesson."

"Little. Fourth grade also listen."

"Little. We do not have the time in school to make a *complete* follow-up of these programs and there is little interest in the homes."

Question: "Do the children perform some experiments at home and make outdoor observations? Much ...., Little ...., Not at all ...."

Answers:

"Little. They are very observing when outdoors and often bring specimens in for study and identification."

"Little. Perhaps here the school is at fault since we have a limited laboratory, and therefore cannot encourage it too greatly."

"Little. There seems to be a lack of interest, due either to too little preparation or lack of knowledge of the subject."

"Little. They have done a few of the experiments at home."

"Little. There seems to be some lack of cooperation at home, so not many experiments are made at home. They do much observing though. In fact, they are well informed on much of the work and are very interested."

SUMMARY

After careful consideration of the answers given by all teachers to the various questions, the following comments seem justifiable.

Previous to the introduction of radio, it was a favorite practice in many schools to teach science from a textbook. The radio motivated pupil participation and science activities. The textbook thereafter became more useful since it served desirable objectives and was no longer an end in itself.

The radio lessons promoted increased interest in science, providing suggestions for experimental and observational work in such a way that large numbers of pupils became more actively interested in their science work and carried their science home with them.

Previous to the introduction of the radio, science was included in many grades. However, the number of grades including science was increased as a result of the radio.

Teachers generally would continue the teaching of science if the radio were discontinued to a greater extent than they had done previous to the radio.

The teacher generally would be handicapped without the aid of the radio, but would be better able to continue the program because of the radio experience.

Radio lessons serve as an aid to the training of teachers in service in many ways.

Large numbers of parents listen to the broadcasts of the School of the Air.

A COMPARISON OF THREE TYPES OF TEACHER ACTIVITY IN DIRECTING THE STUDY OF GENERAL SCIENCE

MYRON S. OLSON AND PAUL E. KAMBLY

The trend toward directed study in the classroom has led to the publication of a few reports on studies designed to determine the relative merits of various procedures. Cunningham [1] carried out an investigation to determine the relative merits of teaching chemistry by two different methods: (1) the "proverbial" plan, and (2) an elaborate plan of "directed-study." In the experiment he taught the same group of pupils by each of the above methods during alternate semesters of the same year. From his findings he concludes that with the "proverbial" plan in recitation and laboratory work, the results were very unsatsifactory except for the very best students. He states,

> "For all but the best three or four pupils, time spent in preparation (unsupervised) of the textbook lesson outside of recitation period was practically wasted." . . . "The total class average for the first semester ('proverbial' or unsupervised method) was 81.7 per cent and for the second semester ('directed-semester') 89.1 per cent." . . . "The new method eliminated discouragement on the part of the weaker pupils by convincing them that they really could learn Chemistry. This change in attitude brought a new interest to the subject."

[1] Cunningham, H. A. "Technique in Chemistry Teaching." *School Science and Mathematics* 22:356–362; April, 1922.

Beauchamp [2] attempted to determine the relative efficiency of two different methods of study which he named semi-directed study and directed-study. From his study he concluded:

(1) "The average number of points obtained per pupil is slightly higher in the directed-study class than in the semi-directed-study class."

(2) "The directed-study class contained more pupils who thoroughly assimilated the subject matter than the semi-directed-study class."

(3) "The results obtained indicate that the method of instruction used in the directed-study class was more efficient than the method used in semi-directed-study class in the total number of ideas gained from study."

(4) "The results obtained indicate that the method of study used by the directed-study class was more efficient in obtaining a thorough assimilation of the subject matter than the method used by the semi-directed-study class."

(5) "Specific training in finding the central thought of a paragraph, determining the questions one must be able to answer in order to obtain an adequate understanding of the topic, and reading an entire block of material through for its general plan, results in a more thorough comprehension of subject matter than undirected study on the same material."

The results obtained indicate the method of instruction he used in the directed-study class was more efficient as indicated by the score of the median pupil and the average number of points per pupil, than the methods used in the semi-directed-study class.

Melize [3] concluded, "How to study is something to be taught before and while the pupil works." She also concluded that students given teacher supervision during study progressed more rapidly than those who received none.

STATEMENT OF THE PROBLEM

The purpose of this experiment was to determine the relative effectiveness of three types of teacher activity during the directed study activities in ninth-grade general science classes.

The school in which this experiment was conducted is a "true" junior high school. The building houses nearly 1,200 students of the seventh, eighth, and ninth grades. The student body is drawn from the entire city and is representative of every class and type of people that congregate in a typical small city.

PROCEDURE

The experiment was conducted with six ninth-grade general science classes. Three groups of two classes each were taught as outlined below, and the data treated as it would have been for three large classes. The three groups designated as Group A, Group B, and Group C, included at the beginning of the experiment, the sixth day of the semester, approximately fifty-five pupils each. The six days were allowed for transfer of pupils due to changes in programs. Any pupil absent more than three days was dropped from the study. The 1936 and 1937 Iowa Every-Pupil Tests in General Science were given on the seventh day of school. The individual scores of the three groups were tabulated from highest to lowest. Scores from the high or low extreme were eliminated until the averages for the three groups were approximately the same. The groups of two classes each happened to be so nearly equivalent that only a few cases were eliminated. With the exception of Tuesday, these groups met for sixty-minute periods. On Tuesdays the periods were cut to forty-five minutes. The lectures, discussions, demonstrations, and subject matter used in each group preceding the supervised study portions of the unit were as nearly identical as possible. No out-of-school assignments were made, and all groups were taught by the same teacher. The units of subject matter covered were the same for all three groups,

[2] Beauchamp, Wilbur L. "Preliminary Experimental Study of Technique on the Mastery of Subject-Matter in Elementary Physical Science." *Studies in Secondary Education, I, Supplementary Educational Monograph*, No. 24. Chicago, Illinois: The University of Chicago, January, 1923.

[3] Melize, D. "An Experiment in Supervised Study." *School Executive* 50: 124–126; November, 1930.

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TABLE I

COMPARISON OF THE THREE GROUPS BEFORE THE EXPERIMENTAL PERIOD ON THE BASIS OF THE 1936 IOWA EVERY-PUPIL TEST IN GENERAL SCIENCE

	Group A	Group B	Group C
Number	51	40	42
Mean	39.470	39.225	40.07
S.D. (dis.)	9.87	10.335	9.81
Diff. in Means	A–C .60	B–C .85	B–A .25
S.E. (diff.)	1.207	1.42	1.55

the basic text being *Problems in General Science.*[4]

At the close of the experimental period near the end of the semester, the 1936 and 1937 Iowa Every-Pupil Tests in General Science were given again. These were scored and the resulting data tabulated. The necessary statistical measures, means, standard deviations, differences in means, and the standard errors of the differences, were calculated.

TEACHER ACTIVITY DURING STUDENT STUDY

The specific procedures followed in conducting the supervised study portion or the assimilative and organization phases of each unit study are discussed in the following paragraphs. The time spent on these phases averaged approximately 60 per cent of the total time spent in the general science classroom.

1. Group A, "Group Method" of Supervised-Study. This procedure involved having the pupils work as a group aided uniformly by the teacher. Proper methods of study, good references, occasional oral study, *etc.*, were offered. On occasions the entire group was divided into smaller sections, the teacher working with smaller numbers at a time. These smaller groups were based on achievement, interests, rate of reading, abilities, personalities, or the students' own choosing within certain limitations. They worked as a unit on problem solving, reports, experiments, bulletin board displays, review, self-testing exercises, etc. At times the students were allowed to work by themselves and were given teacher aid only when it was needed by the entire group. It was assumed that if an error occurred frequently in the work of the class all would profit by instruction in the matter. The room in which this experiment was conducted had movable tables and chairs which made it more convenient for segregation of small groups.

2. Group B, "Individual Method" of

[4] Hunter, George W., and Whitman, Walter G. *Problems in General Science.* Chicago: American Book Company, 1934.

TABLE II

COMPARISON OF THE THREE GROUPS AFTER THE EXPERIMENTAL PERIOD ON THE BASIS OF THE 1936 IOWA EVERY-PUPIL TEST IN GENERAL SCIENCE

	Group A	Group B	Group C
Number	51	40	42
Mean	48.24	53.85	46.07
S.D. (dis.)	9.81	12.11	11.01
Diff. in Means	A–C 2.11	B–C 7.78	B–A 5.61
S.E. (diff.)	1.25	1.64	1.72
Sign. ratio	A to C 1.69	B to C 4.74	B to A 3.26

TABLE III

COMPARISON OF THE THREE GROUPS BEFORE THE EXPERIMENTAL PERIOD ON THE BASIS OF THE 1937 IOWA EVERY-PUPIL TEST IN GENERAL SCIENCE

	Group A	Group B	Group C
Number	51	40	42
Mean	36.88	38.625	37.071
S.D. (dis.)	9.639	10.287	9.30
Diff. in Means	A–C —.19	B–C 1.55	B–A 1.74
S.E. (diff.)	1.38	1.62	1.74

Supervised-Study. With this group the teacher proceeded constantly from pupil to pupil aiding each in his work whether or not the student had requested such help. During the entire study period the teacher offered each student individual study hints, reference selections, correct methods of outlining, *etc.* The teacher attempted to discover individual needs or inefficiencies. The mistakes made by each pupil in his written work determined in part many future lessons assigned to him.

3. Group C, "Help Requested Method" of Supervised-Study. During the student study time the teacher sat behind his desk or stood in some obscure place. If any student asked for information or help, the teacher responded, but no help was "forced" upon any member of the group.

FINDINGS

It should be recalled that this investigation began with six classes of pupils sectioned on the basis of scores on achievement tests in general science to form three groups of two classes each, designated as A, B, and C. Following are the statistical measures based on the scores from these tests.

A comparison of groups A, B, and C before the study period is shown in Table I, which summarizes the data obtained through the administration of the 1936 Iowa Every-Pupil Test in General Science.

On the basis of the 1936 Iowa Every-Pupil Test, it is evident that groups A, B, and C were fairly well matched before the experimental period began.

The 1936 Iowa Every-Pupil Test in General Science was given for the second time directly after the experimental period. Table II presents the data for the three groups.

The original similarity of means shows considerable change. The mean score of group B shows an increase of 14.625 points, group A 8.770 points, and group C 6.00 points.

The difference between the means of groups B to A and B to C are statistically

TABLE IV

COMPARISON OF THE THREE GROUPS AFTER THE EXPERIMENTAL PERIOD ON THE BASIS OF THE 1937 IOWA EVERY-PUPIL TEST IN GENERAL SCIENCE

	Group A	Group B	Group C
Number	51	40	42
Mean	45.06	51.15	43.57
S.D. (dis.)	9.19	10.66	10.88
Diff. in Means	A–C 1.49	B–C 7.58	B–A 6.09
S.E. (diff.)	1.43	1.73	1.74
Sign. ratio	A to C 1.04	B to C 4.38	B to A 3.50

significant in favor of B. The difference between groups A and C is not statistically significant.

The results obtained by administering the 1937 Iowa Every-Pupil Test in General Science also showed the groups to be fairly well matched before the experiment began. Table III presents the data obtained from the three groups at the beginning of the study.

Table IV presents the results on the 1937 tests at the completion of the experimental period.

The gain in mean scores for group A is 8.18; group B, 12.525; and group C, 6.499. The differences between the means of groups B to A and B to C are statistically significant in favor of group B; the difference in groups A and C is not statistically significant, but shows some superiority of A.

It is evident that group B has made the greatest progress, with group A progressing more than group C.

SUMMARY AND CONCLUSIONS

The purpose of this study was to compare three types of teacher activity in the supervision of ninth-grade general science classes. The three study methods used were the "Individual," "Group," and "Help Requested" methods, the groups being equated on the basis of their ranking on Iowa Every-Pupil General Science Tests. An attempt was made to keep assigned work identical. Pupils having extra time during the period were encouraged to do extensive and intensive supplementary reading. Tests were given to all groups before the investigation started, and were repeated at the completion of the experiment in order to measure the increase in achievement made by each group.

The following conclusions are based on these computations, which involved a limited number of cases and are offered with the understanding that they are only tentative:

(1) The "Individual" method of directing study in general science is superior to either the "Group" or "Help Requested" methods.

(2) The "Group" method of directing study in general science is superior to the "Help Requested" method.

THE POSITION OF THE TEACHING OF SCIENCE IN SCOTTISH SCHOOLS AT THE PRESENT TIME *

D. J. S. SUTHERLAND, M.A., B.Sc., PH.D., A.I.C.

SCHOOLS

The teaching of Science in Scotland is carried on at present in two types of school, (1) the *Advanced Division School* where the pupils are non fee-paying, and leave school to secure employment at the age of fourteen or fifteen years and (2) the *Secondary School* where the pupils may or may not be fee-paying and leave school at the age of seventeen or eighteen years. Education is compulsory in Scotland for all children between the ages of five and fourteen. Pupils leave the Primary School when they are about twelve years of age, so that these two types of school provide education for pupils aged twelve to fifteen and twelve to seventeen or eighteen respectively. They need not be separate schools but are frequently only departments in a school which may provide education from the time a child enters the Infant Class until he leaves school to enter the University. In only a few cases are the

* Read by Mr. G. R. Parker, of London, England, before the Science Section of the World Federation of Education Associations, on board the S.S. Rotterdam, August 16, 1939.

Advanced Division and Secondary Department both contained in one school, which is unofficially known as an "omnibus" type of school. The Advanced Division is of more recent origin than the Secondary School, having been created in 1923 to replace the former Supplementary Classes of the Elementary School, whereas the Secondary School is a much older establishment having been formed from the Higher Class Schools and Higher Grade Schools of last century.

STAFFING

Science is taught by university graduates, who, in addition to having studied science at a university, must have had professional training in the teaching of this subject at a teachers' training college, and must also have received instruction in laboratory arts there. There are two types of teacher, the honours graduate who has specialised in this subject and who is eligible to become the head of the science department of a school, and the ordinary graduate who may teach junior science classes and is also qualified to teach primary school classes. The former type is principally employed in Secondary Departments and the latter in Advanced Divisions.

THE ADVANCED DIVISION COURSE

During the first three years of science instruction, the course is practically the same in both Secondary Department and Advanced Division, and consists of the study of the subject for at least four periods per week, i.e. $2/3$ hours. The work is both theoretical and practical, the official title of the subject being Experimental Science. The number of pupils in a class for practical work must not exceed twenty and a class for demonstration lessons must not exceed forty.

SYLLABUS

In the earlier stages, physics, chemistry and biology must form the basis of the instruction. Until 1932, Science was a compulsory subject at this stage of the curriculum, but since then it has been an alternative to Art or French and now only about 70% of the pupils study Science. For many years in Scotland the science syllabus was practically the same at this stage, (which was then called the Intermediate Department), in all schools. The cause of this was the issue by the Scotch Education Department, as it was then termed, of a science syllabus in 1898 and another in 1908. No fixed syllabus is now specified by the Scottish Education Department and each school is free to draw up its own syllabus, which must first be approved by the Inspectorate. This is a privilege which is much prized by teachers, and enables each teacher to work out his own ideas and "exploit to the full his own aptitudes and enthusiasms" in addition to permitting the influence of the environment on the course.

The syllabus is essentially one of General Science and although the content and treatment vary from school to school, there are certain parts of the course which are taught in practically all schools, e.g. the chemical and physical properties of oxygen, hydrogen, air and water, chemical processes, simple experiments in measurement, density and heat. In most schools the syllabus now includes a little magnetism and electricity, some experiments in mechanics, but very little light and practically no sound.

As was stated by the Scottish Education Department some years ago:

> "The chief aims are to interest the children from the beginning in the various phenomena with which they have an every-day acquaintance, to lead them by simple yet striking and convincing experiments to investigate the why and wherefore of these phenomena, and to cultivate in them ability to record their observations and conclusions with accuracy and lucidity. Very properly at this stage the elements of physics and chemistry form the basis of the course of study. Due regard is being paid to logical treatment and sequence, and emphasis is laid not so much on the gaining of quantitative results—many of which mean little or nothing to young pupils—as on knowledge of principles and their application. It was suggested that the personal or human aspect might be increased by more

acquaintance with the lives and work of the great men of science."

BIOLOGY

It should also be noted that Geology and Astronomy are very seldom taught in Scottish schools. The inclusion of Biology, compulsory since 1935, with no corresponding increase in the time allotted to Science and in fact in some cases a decrease, has led to the exclusion of many parts of Chemistry and Physics previously taught and has caused the treatment to be less quantitative and more qualitative than formerly, with the introduction of more demonstration work on the part of the teacher. The time factor has become more and more important. It must be stated that, previously, excessive attention was devoted to practical work which was almost entirely quantitative and was to a certain extent more practical mathematics than science. The abandonment of the academic tradition which was accompanied by the pedantry of the laboratory has resulted in the creation of a new technique in science teaching, but it is considered that in some cases the teaching is "still not sufficiently in touch with the interests of every-day life, and the method of lecture with suitable illustrations to arouse interest in some of the wider aspects of Science has not been utilised to the extent it deserves."

The introduction of Biology has been rather slow and was at first somewhat unpopular. The main reason for this was that science teachers were principally qualified in Physics and Chemistry and possessed little or no knowledge of either Botany or Zoology. Voluntary attendance at summer courses in Biology has helped to remedy this state of affairs. The course in Biology deals usually with the study of the functions of the parts of a flowering plant, germination, growth, transpiration, respiration, photosynthesis, and the characteristics of a few natural orders, while the study of animals is frequently introduced by the life-history and habits of common animals such as the frog, salmon and butterfly. Recently the study of Human Physiology has been included in the Biology syllabus of a number of schools. The danger in Biology has been the teaching of a disconnected series of lessons on plants and animals without any biological unity, but instruction in this subject has now attained to a reasonably high standard and Biology is playing a useful and increasingly important part in the study of Science. It has been aided greatly by the weekly wireless lessons of the British Broadcasting Corporation broadcast to Scottish Schools by distinguished biologists and utilised by 4,069 children in 143 schools during the past year.

TEXT-BOOKS

For many years there was a prejudice against the use by the pupils of text-books, but now these are in common use. This is due partly to the time factor already mentioned and to the introduction of Biology and General Science into the syllabus, also to the publication within recent years of many suitable text-books.

Within recent years there has been much more use made of visual aids such as the cinema, film-strip projector and micro-projector. Some enthusiastic teachers have even produced their own films for illustrating their science lessons.

In country schools there is usually a course of Rural Science, which is accompanied by instruction in gardening, bench-work, and frequently in rural occupations, such as bee-keeping and poultry-keeping. The subject of Rural Science may be very comprehensive and include study of soils, weather, air and water, mechanics and biology, particularly the practical aspects of this subject. For such schools the British Broadcasting Corporation provides in both England and Scotland a course entitled "Science and Gardening" in which the lessons are given by the assistant director of a famous experimental station and by an experienced horticulturist. In some sea-

board towns and villages Navigation is studied by boys in post-primary schools.

At the end of the three years' course which we have been considering in Advanced Divisions and the earlier part of the Secondary Department, those pupils who are leaving school may be presented as candidates for the Day School (Higher) Certificate, to secure which, passes must be obtained in four subjects. This certificate is issued by the Scottish Education Department. For this examination the teacher must give an estimate of the ability of the pupil, then to confirm the mark given by the teacher, there is an examination both oral and practical (and occasionally also written), by His Majesty's Inspector of Schools, who has been, in most cases, a teacher of science prior to receiving his official appointment.

THE SECONDARY SCHOOL COURSE

The duration of this course is either five or six years, the work during the first three years being the same as that in Advanced Divisions, namely an elementary course in General Science, including Biology. During the fourth year a more intensive study of the subject is begun and attention is concentrated on certain branches of science. The goal to be reached at the end of the Secondary School course is the Leaving Certificate issued by the Scottish Education Department and the syllabus for this certificate permeates the teaching in the Secondary School in a way that the Advanced Division is not affected.

Mathematics or Science must be studied to the standard of the Leaving Certificate but may be passed on either the Lower or the Higher Grade. In Science there must be chosen some approved combination of Physics, Chemistry, Botany, Zoology, Geography, an applied science, e.g. Engineering, Agriculture. Usually only two subjects are studied, the commonest being Physics and Chemistry. The statistics for last year show that of 232 schools presenting candidates in Science, 46 had taught Botany, 11 Pure Zoology, 1 Zoology and Human Physiology, 180 Physics, 188 Chemistry and 33 Geography. The relative popularity of these branches of science is shown more strikingly by the numbers of candidates in each branch, viz., Botany 324, Pure Zoology 82, Zoology and Human Physiology 5, Physics 1,773, Chemistry 1,912, and Geography 165.

For the Lower Standard of this certificate there is at present no written examination except in Geography but oral and practical tests are given based on the more elementary portions of the syllabus for the Higher Grade. A detailed syllabus is issued for the latter and shows the work to be studied in each branch of science. The paper in Physics contains four sections (1) Mechanics, (2) Heat and Hydrostatics, (3) Sound and Light, (4) Magnetism and Electricity. Questions must be answered from the Mechanics section and from at least two other sections.

The Leaving Certificate admits to the universities and exempts the holder from various professional entrance examinations. The written paper for this certificate occurs in March and may be sat in either the 5th or 6th year of the Secondary Course. In consequence, much hard work must be done in the fourth year and beginning of the fifth year in order to prepare the puplis in time for this examination. Only in 1926 was a written examination introduced in Science, the examination prior to that being entirely oral and practical.

The time devoted to Science in the fourth and subsequent years of this course is usually eight periods of forty minutes each, i.e. 5 1/3 hours. Throughout this course use is frequently made of the film, filmslide, epidiascope, lantern and micro-projector to illustrate the lessons, and visits are paid to works and museums, while in Botany field work is carried on. No broadcast lessons are provided by the B.B.C. for this part of the course.

As regards the provision of laboratory

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assistants, teachers in Scotland are singularly unfortunate, for only in a few of the old-established schools is there a laboratory assistant, while in several schools a senior boy pupil receives a small payment for such work performed before or after school hours.

PRIMARY SCHOOLS

It should be mentioned that no Science, as such, is taught in Primary Schools or Departments but Nature Study of a very elementary nature must be taught, and this is done by the class teacher, not by a science teacher. In addition the B.B.C. broadcasts a very interesting series of Nature Study talks for Scottish schools and last year 31,205 children in 549 schools listened to these talks.

CHANGES TO TAKE PLACE THIS YEAR

As a result of the new Day Schools (Scotland) Code, 1939, various alterations take place during next session in Scottish education, and several of these affect the teaching of Science.

The Advanced Division will no longer be a separate department from the Secondary Department, and all post-primary education will be classed as Secondary. In this there will be two types of school, the Junior Secondary School providing a course of study for three years, and the Senior Secondary School for five or six years. At the same time, the Day School (Higher) Certificate will be replaced by the Junior Leaving Certificate and the present Leaving Certificate by the Senior Leaving Certificate. In the latter there will be introduced a written examination for a pass on the Lower Grade in Science, and the candidates will have to answer questions in General Science, including Biology, and in at least two of the branches—Physics, Chemistry, Botany and Zoology. This alteration is important as it renders compulsory the continued study of Biology by those pupils beyond the first three years of their course.

Geography now ceases to be treated as a branch of Science and will be treated as an independent subject.

Another alteration intimated is that the study of Biology during the first three years of a secondary course must include Human Physiology. This is a very praiseworthy extension of the Biology syllabus, or rather it would be if additional time were allotted to Science, but it will be practically impossible to do justice to such a curriculum when it is remembered that in the course of three years, of usually only four periods per week, there must be studied Physics, Chemistry, Biology (both plant and animal studies) in addition to Human Physiology. For many years science teachers have made a plea for six periods per week but they have been unsuccessful in their claim, owing principally to the additional time now devoted to physical training.

It had been hoped that science might have been made compulsory under the new Day School (Scotland) Code, 1939, so that scientific instruction might have been given to every child in this modern age where, in every-day life, one encounters almost continually the effects and uses of scientific knowledge and invention, but unfortunately science is not obligatory in schools. It is a matter of regret that at present about 10,000 children leave the post-primary school every year without being given the opportunity of any instruction in scientific principles.

It is also unfortunate that many girls studying domestic subjects are not taught science and so have no knowledge of the scientific principles underlying the practical work with which they are familiar.

If, however, science teaching does not reach every pupil, it is nevertheless a great pleasure and a great source of interest to those pupils who do study this subject, and it is one of the most popular subjects in the school curriculum.

In the Memorandum explanatory of the

new Code, the treatment to be given to the teaching of science is stated thus:—

> "Science should include the study of natural as well as of physical science, and elementary physiology in relation to hygiene; emphasis should be laid on qualitative as well as on quantitative work, and the pupils should be led to appreciate the importance of the applications of science in matters of every-day life."

It will thus be seen that the teaching of science in Scotland today is by no means static, but is thoroughly progressive, nor is it a mere pedantry of the laboratory and the schoolroom but a proper scientific training in that branch of science which is almost unlimited in its scope, the science of every-day life.

THE NATURE OF LECTURE DEMONSTRATIONS IN PHYSICS

RICHARD C. HITCHCOCK

Electrical Engineer, Westinghouse Electric and Manufacturing Company, Newark, New Jersey

In presenting lecture demonstrations in physics, it is desirable that the lecturer combine the desirable attributes of a physicist, a magician, and an orator. As a physicist he is also a mathematician, as a magician and an orator he must be a psycologist and a sociologist. In addition, to construct and set up equipment it is necessary to be something of a mechanic and an electrician. The desirability of demonstration methods is ably treated elsewhere. In addition, there are several papers which discuss the relative importance of such methods.

It should be kept in mind that science development starts with sense perceptions of things which exist or happen, carrying on through classification and associations (relations between facts). The development begins with conjecture, through classification of theories and principles, on to generalizations and laws of universal applicability. While educational values can be gained in extracurricular activities, these are beyond the present scope.

The goal of knowledge in science is to find relationships between phenomena, though not so far as to involve ultimate causes, since these lie in the realm of metaphysics. Science tries to discover part of truth and to put it in order tentatively. Teaching science means teaching the accepted facts of today because time changes the perspective and importance of scientific facts. Scientific attitudes are desirable, but will not be treated here.

Education may be regarded as training for meeting a situation in life, and this is especially true in science education. To cope adequately with a situation in life, a series of events must transpire. Classifications as to similarities and differences is one of the first approaches, and to teach these as the subject progresses will be of positive benefit, both immediately, and later on.

Reasoning is a most important term, in which a host of complex activities are included. True reasoning includes perception of both cause and effect, and should embrace the classification of both. The term "reflective thinking" may also be applied to this process. It is necessary in considering causes and effects to take into account both time and place. A complete understanding of the effects as related to time, allows prediction, an important tool of science.

The goal of society has been admirably stated as the "adaption to a perfectly universal environment, securing the greatest harmony among the elements of society, their greatest efficiency in mutual cooperation, and their greatest capacity for survival."

Adequate science teaching can aid

greatly in the adaptation process. The other factors are in the field of sociology, and should proceed harmoniously to produce a well-rounded individual; one who can cope with new situations, or with old ones, with the greatest effectiveness.

In order to do this, six major criteria are suggested as a means of judging a good demonstration lecture. There are:

1. Judging the Audience
2. Appealing to the Sense Perceptions
3. Considering the Time, Room, and Facilities Available
4. Choosing Appropriate Terminology
5. Arousing and Sustaining Interest
6. Selecting the Type of Lecture

1. JUDGING THE AUDIENCE

It is essential that the group to whom the lecture is to be presented be clearly in mind if the greatest usefulness is to result. While the problem is simpler if the group is homogeneous in various factors, some degree of effectiveness is possible even when the group is composed of heterogeneous elements, if these elements are recognized at the outset and some effort made to appeal to each. For example, the ideational types, as described by psycologists, must be considered.

A predominant element, one which should be uppermost in the lecturer's mind as he proceeds, is the culture patterns of his audience. Culture patterns may be defined as "ingrained habits respecting common surroundings which increase the comfort and power of the individual" since he knows how his fellows will act. Thus the culture pattern assures social unity, and further, since the major interests of life are vested in these patterns, they cannot be disturbed without resistance—and if resistance is encountered, strong emotions are aroused. As an example, The Tennessee Evolution Trial indicates how ingrained culture patterns will resist efforts to inculcate scientific habits of thought.

From culture patterns come ethics, the behavior necessary to secure human values which are closely allied to morality. The ethics of an adolescent audience may be only partly formed, but in an older group should be considered for certain classes of lectures. The application of a scientific principle to human affairs involves the use of ethics. Science of itself is neither good nor bad, but the ethics of the promoter determines whether or not the application is for good.

A sociologist says that both instincts and emotions lead to four basic human wishes; security, response, new experience, and recognition. By directing the lecture toward one of these wishes, a ready appeal is possible. Much of science is "new experience," but if this wish alone is cultivated, the interest soon fades, since there are too few basic new experiences to keep up the pace. Recognition of work well done is a powerful incentive for any individual.

The reason for any human action is to secure human values. Values are measured by emotions, which are only one step removed from instincts; thus they are closely associated with culture patterns. A personal value may be described as the feeling associated with a useful, satisfactory, or pleasant contact of individual with individual, or between an individual and his environment.

2. APPEALING TO THE SENSE PERCEPTIONS

The contacts between lecturer and audience are largely determined by the two senses of sight and hearing. Since this is true, it is important to make sure that the phenomenon is large enough for all to see clearly, or loud enough for the audience to hear in a satisfactory manner. The senses of touch, smell, and taste are infrequently used in lectures on physics, although some of them are quite essential in laboratory work.

Under sense perceptions may be listed two possibilities; either to perceive the phenomenon directly, or to perceive the phe-

nomenon indirectly through a translating agency which makes it visible or audible.

Perception can be used to distinguish phenomena (directly or indirectly) which are either static or changing. Frequently, accurate perceptions of a changing situation are all that are necessary to get a good conception of the elements involved, particularly if the elements are known in advance, either by description or by experience. Since the two senses which predominate in importance in lecture work are those of sight and hearing, a large group of physical phenomena, such as demonstration experiments in mechanics, can be observed directly, in three dimensions; the elements of sight perception being size, shape, motion, and color.

Considering direct perception methods, physical meanings can be illustrated by models of various sizes. The models may be smaller than the "life-size" device which is explained, for example the expansion of a small ring when heated gives the fundamental idea underlying the process of applying a steel tire to a locomotive driving wheel. The model may be actual size, as for example the experiment of determining the speed of a rifle bullet when shot into a ballistic pendulum, or finally the model may be larger than the situation illustrated as for instance models of atomic structures. Sometimes the relation of the size of the model to the practical application is so clear to the lecturer and to most of the audience that this is not mentioned specifically. It is necessary for a few, and of no harm to the rest, to mention the relative sizes of a model to its actual counterpart.

Continuing with direct perception methods, the material may be so chosen that, while typical of the class of phenomena being discussed, the affect which is elicited from the cause is larger than that encountered in practice. For example, the extension of a soft rubber bar under equal and moderate increments of loading are great enough to show in a manner, which is clearly visible, the same kind of effect that a steel bar would give under load. However, in the case of the steel bar, multiplying mechanisms would be necessary to show the amount of extension produced. Here, as mentioned just previously, the change in material from that generally used should be stated clearly.

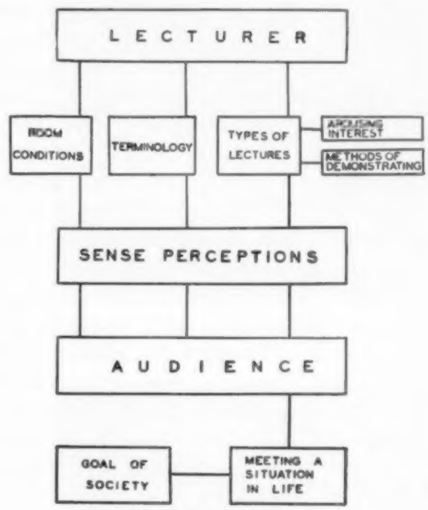


FIGURE II–1

Also under direct perception methods can be treated the matter of the speed at which a phenomenon is to take place. Sometimes it is best to make arrangements to have a much slower than "natural" speed, so that the eye can follow the associated motions. Models of gasoline engines, with the cam shaft, valve actions, and a lamp which lights when the spark should occur, are helpful in giving the proper sequence of events. There is also something to be said in favor of operating machines at the same speeds as those encountered in practice. Centrifugal forces being proportional to the square of the speed of rotation, it is difficult to secure satisfactory illustrations at speeds slow enough for the eye to follow. While an indirect method using stroboscopic means has many desirable features, as are dis-

cussed later, it is quite possible to show centrifugal forces at normal speeds, with the unaided eye.

To show the effect of centrifugal force with a minimum of equipment, a circular sheet of soft rubber is held against a thin metal disc of somewhat larger diameter by a central screw and washer on a motor shaft. It is essential that the fastening be only at the center, to allow the rubber to stretch freely in a radial direction. Draw a circle on the metal disc, spaced from the unstretched size of the rubber disc. When the motor comes up to speed, the rubber disc expands radially covering up the circle. The "growing" of the rubber disc, clearly visible to the audience, is a good illustration of centrifugal force in actual operation, see figure II–2.

In some instances it may be desirable to run some experiments at a speed faster than normal to enhance the effect. The speeding up of the planetary motions in a planetarium is a good example. For experiments in mechanics it is usually best to perform most experiments at a fairly slow speed, in the interest of safety.

Taking now the indirect perception methods, electric currents in wires may be considered as one of the class of phenomena for which such methods must be employed. While it is true that some hardy indivdiuals test 110 volt circuits with two fingers of one hand it is also true that this procedure may be quite dangerous. Moreover, the test is solely for electromotive force, and cannot be used for currents and other electrical quantities. In general, then, a translating means must be provided to demonstrate the effects of electricity. The galvanometer, voltmeter, or milliammeter will serve to show the presence and magnitude of a current flowing, and in the case of direct current, the direction also may be shown. Here the problem is one of making an invisible force act on some intermediate device so that a visible reaction is the result.

As mentioned previously, the use of a very bright light of extremely short duration is very useful in "stroboscopic" analysis of rotating objects such as a rubber flywheel with a broken spoke, the extension of the rim being very striking at full speed, see figure II–3. The advantage of this method over the one shown in figure II–2, is that the stroboscope permits detailed analysis, and in addition to the centrifugal force which acts on the rubber flywheel uniformly, it also permits the examination of special conditions in a particular spoke.

The translating of a phenomenon into sound is another useful means of indirect perception. An audio amplifier receives electrical energy from a phonograph pick-up, and in such succeeding stage it increases the voltage or power of the impressed signal. Unless a loud speaker, or other reproducer is connected to the output of the amplifier, the electrical energy is inaudible. The use of audio transformers with iron laminations which are stacked "dry" (without impregnation of any kind) will sometimes serve to show that the amplifier is functioning. It is also possible to "plug-in" at various stages with the loud speaker, showing the steady increase of the power of the original signal, as it passes through the amplifier.

Other phenomena can be shown by sound devices. The variation of the carrier frequency of a radio station can be shown by using a second local generator of similar waves, and then using a regular radio receiver to detect and amplify the result. The "whistles" of early radio sets were simply the beat notes of the difference between the frequency sent out by the broadcasting station, and the oscillations generated by radio receivers.

The use of analogues is a combination of the direct and indirect methods. It involves a direct method where each of the elements can be viewed without translating elements—but it is designed to show the action of another phenomenon indirectly

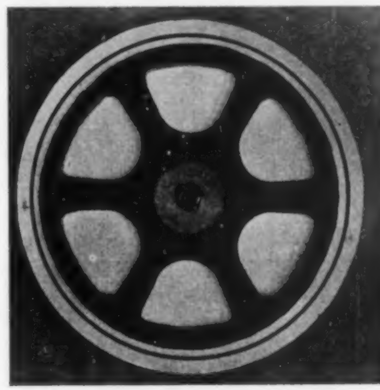
—by comparison. It is highly important that the strict correspondence be pointed out where it exists, and equally important to point out just where the analogy breaks down, and there is no correspondence, or there may even be an actual disagreement.

Suppose that a hydraulic analogue is used to illustrate electric current circuits. The glass tank simulates the electric battery, and the glass tube at the base is the metallic conductor. Drawing off a steady flow of water makes a difference in height of the liquid in several vertical glass tubes, illustrating the fall of potential due to resistance along the "line". The usefulness is in the direct visibility of all the essentials, as contrasted with the necessity of using translating devices, voltmeters and ammeters, with electric currents. Among the differences to be pointed out are; the use of a single tube for the meter, while the electric current requires a closed circuit with a return wire to the battery; the speed of travel of the water is much slower than that of electricity; and water flow is a physical movement of molecules, while electricity is a motion of free electrons. An electric current, in addition, has an associated magnetic field for which the water analogy has no counterpart.

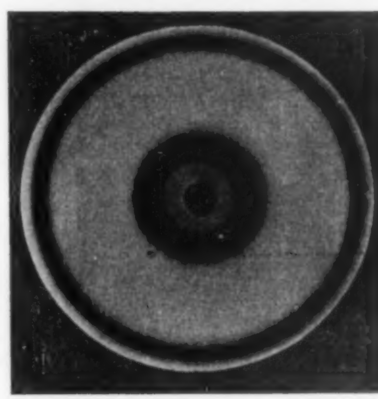
3. CONSIDERING THE ROOM, FACILITIES, AND TIME AVAILABLE

While actual apparatus is properly treated in detail elsewhere, the various types of facilities available can be treated in a general way in this section. It is beyond the present scope to consider the layout of a room for physical demonstrations; it is assumed that a room is available. It is proposed to deal with the effects of humidity, temperature, light and sound on the physical conditions in the lecture room.

Experiments in electrostatics cannot readily be carried out under conditions of high humidity, since the surface resistance of the insulators is so low that the small electric charges leak off rapidly. High humidity is characteristic of summer weather, but some air-conditioning equipment provides added humidity even in cool weather, so that it may be necessary to turn off this part of the system when con-



Rubber wheel at rest, note black circle on white disc.

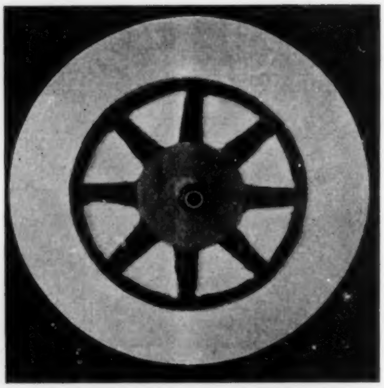


Rubber wheel at 1800 r.p.m. Note that centrifugal force has stretched spokes: the circle is now covered up.

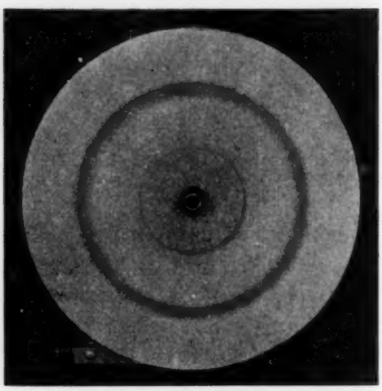
FIGURE II-2

ducting this type of experiment. Generally, electrostatic experiments are most successfully performed in winter months when the relative humidity is low.

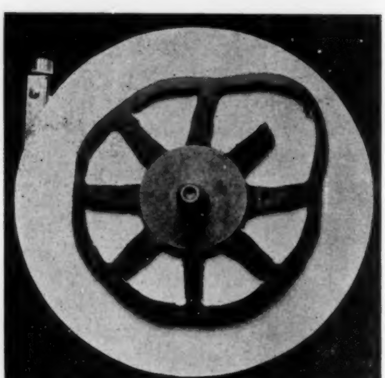
Few other physical demonstrations are concerned with humidity values, the exceptions being those in light where the surface



The rubber wheel at rest.



The wheel at 1800 r.p.m.



The wheel at 1800 r.p.m. Lighted by 1800 flashes of light per minute. The rim, bulging away from the cut spoke, illustrates the result of centrifugal force.

FIGURE II–3

may become coated with "dew" when suddenly brought from a cold store-room to the warmer lecture room. Experiments with comparatively heavy currents, such as are used in magnetism, have low resistance circuits, so that ordinary insulation leakage will cause no difficulty. The one criterion is the amount of leakage resistance, which must be less than the order of magnitude of the effect to be shown. In this class are some photoelectric circuits, where the grid-leak values may be as high as 100,000,000 ohms. Commercial photoelectric devices prevent trouble from this source by placing the high resistance close to sources of heat, either tubes with heated cathodes, resistors carrying heavy currents, or transformers which are designed to run at substantial increases of temperature above ambient. This added heat decreases the relative humidity in the vicinity of the high resistance, minimizing leakage troubles.

Ordinary room temperatures have little effect on physical demonstrations, except as they may control the humidity, as previously mentioned in connection with circuits of high resistance.

The regular room illumination is required except for projection demonstrations. It is desirable to have extra light directed on the lecture table, and not in the eyes of the audience, yet it is equally important to have sufficient light throughout the room to facilitate note-taking. During the use of a projection lantern it is desirable to maintain two to five foot-candles of illumination in the room by lamps over the lecture table, but these must be shielded from the audience. A powerful projection lantern is very helpful in permitting the use of a low residual illumination in the room. Suitable window shutters are quite necessary to show projection lantern slides during the daytime.

Spot lights giving a bright small angle beam can be used to advantage to bring attention to some particular piece of apparatus.

For all but a few demonstrations in sound, little attention need be paid to external sounds, unless they are strong enough to detract from the clear understanding of the lecturer. However, when unfamiliar sounds are to be detected, as in sound experiments, it is essential that extreme quiet be maintained.

For a large hall, an amplifier system has many advantages, both for the reduction in strain on the voice of the lecturer, and for the hearing of the audience. In this case a lapel microphone for the lecturer is desirable since it permits free movement about the lecture table. For those hard of hearing, it is relatively simple to provide loud-speaking receivers when an amplifier is already in use.

The equipment to be demonstrated must, of course, be adapted to the facilities available. These may be grouped into three general conditions; first, the usual full-equipped physics lecture room; second, the case when the physics demonstration lecture must be given in a room not particularly adapted for the purpose, although some facilities are available; and third, the not infrequent occurrence of the necessity of giving the lecture in a room in which no facilities, or at most an electric lighting circuit is available.

In the first case, a physics lecture room, when direct and alternating currents are available at various voltages and frequencies, with ample current ratings, as well as hot and cold water, gas lines, vacuum line, compressed-air, and projection-lantern equipment, the greatest freedom is possible in the selection and use of physical apparatus.

For the second case, with limited facilities, the active working models must be adapted to the power available. As an example, in certain sections of some cities only direct current is supplied, and it is impossible to operate alternating current equipment, with the exception of heating and incandescent devices of the proper voltage. Here a direct to alternating current concerter of the desired output frequency and power may be used, and some utilities have available such units for loan, when given sufficient advance notice.

The third case includes the "after-dinner" variety of lecture. Some lecturers handle this situation by showing pieces of equipment which are not actually operated, but whose function is explained in detail. This procedure may lead to the carrying of fairly large pieces of equipment.

Since the use of utility power is practically out of the question in this third case another useful scheme may be mentioned—to use equipment which is "self-powered". One great advantage of this scheme is that the volume is small and weight is a minimum, permitting the carrying of the equipment in a brief-case. The accompanying disadvantage is that small equipment is difficult to display convincingly to a large group. This however, is partially offset by the possibility of passing the device around among the listeners so that they can operate it themselves while they examine it. In this class of "self-powered" devices are photoelectric foot-candle meters, incorporating photovoltaic discs and microammeters, the latter operating on a fraction of a microwatt of energy.

An example of this latter is the "electrynx" in which pins of zinc and silver are fastened to the terminals of a 0–20 microampere miniature electrical instrument, two inches in diameter. By inserting the dissimilar pins in fruit, such as an apple, a difference in reading indicates approximately the relative acidity (or sweetness) of various parts of the apple. This little device is merely an application of the wet-battery principle of volts, established over a century ago. The small size and weight, and its surprising sensitivity makes it a desirable piece of demonstration equipment particularly suited to conditions when normal facilities are lacking. A further description of the sensitivity of this micro-

ammeter, and an illustration of the microwatt power term, is given in Section 5.

Another "pocket demonstration", suitable for the third class, is the two small disk polarizer-analyzer which illustrates very strikingly, with a minimum of equipment, and no "set-up" or power requirement, the principles of polarized lights. The addition of a simple bar, one-half inch square, or a small horseshoe of clear bakelite resin (or clear plastic material) to be flexed while viewed through the "crossed" polarizing members, is sufficient to illustrate by the colored, changing strain lines, the important industrial use of photoelastic methods of strain analysis in models.

The amount of time available for unpacking and setting up apparatus has an important bearing on the kind of demonstrations which can be shown. Complicated equipment which should be thoroughly checked in place on the lecture table, such as optical systems requiring centering and focusing, requires time, and this should be taken into account when planning the lecture.

In some cases, when the lecture hall is used for other purposes, the time available for set-up is rather short. Here the use of wheel-equipped tables is a help in bringing in apparatus already set-up.

As previously noted, a minimum of set-up time is needed for "self-powered" devices, and this is frequently the best answer to a situation when practically no time is available before the demonstration. When new demonstration equipment is to be used, sufficient time should be allowed to clear up any "loose ends" or uncertainties in the operation.

Thought should also be given to the time available for picking up after the lecture, though this is relatively a much faster process than that of setting up.

The time for preparing the talk should also be kept in mind, since the factual material, references, and so on, are best given during a lecture when prepared in advance. Further material on the types of lectures is given in section 6.

The time available for giving the lecture should be divided up in advance so that the essential points can be made and the demonstrations performed with adequate time for each. An approximate time schedule can readily be followed if a lecture table (or other) clock is provided.

Concerning time for preparation, an anonymous story may be interjected. It is the story of a young minister being examined before ordination. He was given a text and asked how long a sermon he would preach on it. He replied, if he must do it without preparation, an hour and a half; if he had a week to prepare, an hour; if he had a month, he could do the job in twenty minutes.

As a final consideration of time, it is usually axiomatic that demonstration lectures which must be given on short notice had best include time-tested experiments.

4. CHOOSING APPROPRIATE TERMINOLOGY

To a person who is encountering science for the first time, one of the obstacles is the vocabulary. Many words are applied to the same thing; speed, velocity, and rate of change of distance, each must be made clear in order to understand mechanics.

Some relatively simple words are used in different senses. "North pole" is frequently used to mean one of three different things. The north geographic pole is located at one end of the earth's axis of rotation, and is the one which may be the most familiar. The north magnetic pole is located in northern Canada, and is the pole to which the magnetic compass "north pole" is attracted. The "north-seeking pole" of a compass is the one which points toward the north magnetic pole, but the anomaly of a north pole (of a compass) pointing toward a north magnetic pole, (of the earth) may easily cause confusion, since one of the fundamental principles of magnetism is that like poles repel each

other. Once the fact that all magnet poles, compasses, electromagnets, and permanent magnets are considered to have "north-seeking poles", the term may at that time be abbreviated to the simpler "north pole" with little loss of clarity.

Upon introducing a new subject, a few minutes making clear the terms to be used will be desirable; particularly to an elementary-minded group. In addition, as the terms are used during the lecture, the various synonyms may well be introduced.

5. AROUSING AND SUSTAINING INTEREST

The lecturer has at his disposal many techniques not available to a writer. On the other hand, both the writer and the lecturer should arouse interest in those to whom their effort is directed. Figure II–4 is a pictorial representation of "interest structures", figure II–4C being applicable to lectures as well as to technical papers.

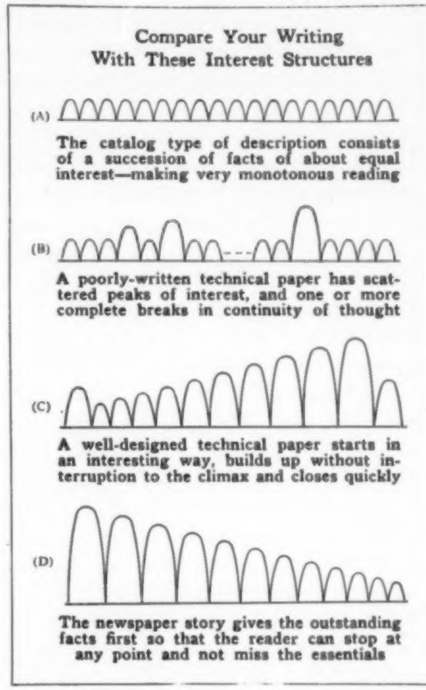


FIGURE II–4

It is difficult to indicate enthusiasm in a technical paper; but the enthusiasm of the lecturer for his subject, as evidenced by his presentation, has a great bearing on the interest which can be aroused. Mastery of the subject, whether or not the particular item is difficult, is usually sensed, perhaps subconsciously, by the listener. Facts learned with a pleasant emotional association are more likely to be retained.

Change of pace, a term borrowed from the field of sport, is expressive of an important scheme for keeping up interest. The pitch of the voice, even if one is unfamiliar with music, can be varied to indicate the importance of certain important elements. An earnest tone readily awakens the hearer to the fact that something to be remembered is being presented. At times it may be desirable to speak rapidly, giving difficult matter in a glib fashion—and then when the listener realizes that this is of importance (or whether he realizes it or not) the material should be repeated slowly, and with emphasis. Well considered repetition is good psychology, but it should be done with some knowledge of the effect; repeat in a different pitch, or at a different rate of speed—a change of pace.

One particularly inspiring lecturer, renowned for his charm as well as for his superior pedagogy, at times lowers his voice to a penetrating whisper, and then abruptly changes the volume to a loud tone. This change of pace is very effective.

As popularly expressed, though not entirely correct, the magician presents his tricks so speedily as to warrant the use of the phrase "the hand is quicker than the eye". The physicist may find it desirable to do some experiments quickly and puzzle his audience—but immediately thereafter the pace should be changed, and made slow enough for all to see—so that there is really no mystery at all, each move should be made toward a definite end, the complete understanding of all.

There is also a similarity in the "timing" or "showmanship" of a good physics lecture and a good legerdemain performance. The magician explains only enough of his experiment to focus attention on the place where the trick is to occur, and the trick is performed when the audience is expecting it. The physicist should go one step further by preparing the way for the experiment in a general manner, but should not give quantitive details in advance. For example, in the experiment where opposite currents in two similar coils of wire are to cause the top coil to jump up in the air, just as the word "jump" is uttered, the actuating switch is closed, and the coil jumps. This is proper "timing", and the complete explanation should follow immediately. Improper timing of the explanation would decrease interest; for example if the preliminary statement was "the top coil will now jump up ten inches from the bottom coil," much of the desired experimental attitude, and its associated interest, would be lost.

To one who has seen the splendor of the skies burst forth on the dome of a planetarium after a dark period, the impressive change from dark to light can be appreciated. This can be approximated in the lecture room by the use, first, of some phenomenon which is too small to be readily seen by all, and then by the presentation of a greatly enlarged image on the projection screen.

The use of amplifiers frequently permits a change of pace. The ticking of a watch can be focused by mirrors and projected to a distance, and then by suitably moving the mirror its field can include successive portions of the audience. A microphone located at the focus of one mirror while the other containing the watch is manipulated to direct its sound into the mirror microphone (with its associated amplifier and loudspeaker) makes a positive impression.

When some demonstration is being made in which the instruments are small, sometimes attention is distracted, since complete understanding is difficult. Here a variation of the magician's technique may be employed. The magician asks the assistance of a boy in the audience to help with the next trick. Sometimes the boy is subjected to ridicule by the magician, but this is furthest from the purpose of the physicist. On the contrary, the assistant in a physics demonstration takes a useful and honorable part, and the group reaction of having one of their number perform the experiment is favorable. As an example, suppose that the voltage across an electric arc is being studied in relation to the current, and the voltmeter available is too small to be seen by all. Here the young assistant reads off the successive values for his associates to copy, and interest is secured where the unaided lecturer might fail. It might be added that the one to choose for an assistant may well be one who otherwise would be the first to lose interest; with a definite and responsible task to perform, his active cooperation at once results.

The use of short, pointed anecdotes may come natural to some, and to those it may be a very valuable means of arousing and sustaining interest. Little happenings of a personal nature, bearing directly on the subject, very often make the matter much clearer. A somewhat humorous approach, dealing directly with the fundamentals, is better than stories meant to be funny, but which unfortunately may fail of their object. The telling of jokes is a procedure to be used with great caution if at all.

As an example of an anecdote, the ancients in addition to some correct ideas, had some peculiar notions about the properties of magnets. Magnets were supposed to lose their power when rubbed with garlic, but to recover it when treated with goat's blood. Also, magnets were supposed not to attract iron in the presence of a diamond.

While the ancedotes may cover somewhat the same ground as illustrations, it

may be well to note some particular types of illustrations which may prove of value. A good illustration makes an unfamiliar item clear by comparing it in a definite and understandable manner with something which is quite familiar.

A 25 watt electric light bulb is familiar to nearly everyone. The energy to produce light is largely wasted in heat, but the total energy input is 25 watts. Suppose this familiar figure is compared with a sensitive electrical instrument with a resistance of 2,000 ohms, which reads 0–20 microamperes d-c. Using I^2R, the energy is calculated to be 0.8 microwatts. Since no one ever saw a common device using such a small amount of energy as a microwatt, the term means little. But to divide the 25 watts by 0.8 microwatts gives 31,250,000. The energy of a 25 watt bulb could actuate over 30 million microammeters to full scale; yet this is still too large to be comprehended readily. Taking the cube root of 31,000,000 to be 315, the energy of a 25 watt bulb could actuate a solid cube of the microammeters, stacked 315 on a side and, if each occupied a space of $2\times2\times2$ inches (1/6 ft. on a side), a room $50\times50\times50$ ft. full of the instruments could all be made to read to full scale by the energy required to light a single 25 watt lamp.

As a second example, using the same methods, the approximate diameters and weights of the electron and neutron are known. The radius of the electron is 2×10^{-13} om., and its mass is 9×10^{-28} g. Both these figures are so extremely small that no adequate comprehension is possible. But it is a matter of elementary calculation to find the mass per unit volume of a sphere; here $\times=9\times10^{-28}/4/3^{-}\times2^{3}\times10^{-39}=27\times10^{9}$; or 27 billion grams per cubic centimeter for the electron: This is a figure of practically inconceivable density, but the neutron has an even greater density, since it is 1835 times as heavy as the electron, and it has approximately the same diameter. The neutron density is $1835\times27\times10^{9}$ or 49×10^{12} grams per cubic centimeter. Here an interesting illustration can be given since neutrons have no charge and can, at least in imagination, be piled together in a compact mass.

To do this, assuming that a teaspoon holds ¼ cubic inch, or approximately 4 cc, a teaspoonful of neutrons would weigh $4\times49\times10^{12}$ g., 200×10^{12} g., 200×10^{9} kg., 420×10^{9} lg., 210×10^{6} tons, 210 million tons. Since the gross tonnage of the R.M.S. Queen Mary is 80,800 tons, the 210,000,000 tons mass of neutrons weighs the same as 2600 "Queen Marys".

In making her 1938 record, 30.99 knots in crossing the Atlantic, the Queen Mary covered 2,907 nautical miles between Ambrose Lightship off New York, and Bishop's Rock, England. In this distance 2,600 boats could be placed 6,800 ft. from bow to bow: for boats 1,000 ft. long there would be 5,800 ft. of open water from stem to bow between boats.

The final comparison, the illustration sought, is "a teaspoonful of neutrons weighs the same as a line of 80,800 tons boats extending from Ambrose Lightship, New York, to Bishop's Rock, England, with 5,800 ft. of open water between each boat."

In short, "illustrations" may be thought of as simply expressed and clarified ratios between familiar and unfamiliar things.

6. SELECTING THE TYPE OF LECTURE

The purpose of a physics demonstration is not to imitate a circus, or to put on a show. A lecture should raise and answer questions in the mind of the listeners. Six questions that are covered by a newspaper feature story are "Who, Why, What, When, Where, and How?" In addition, science also asks the quantitative question, "How much?" The logical lecture answers the question, "What, When, Where, How Much?" The psychological type answers the question, "Why?" The historical type stresses, "Who, and When?"

The popular type usually omits the question "How much?"

Some of the lectures may be given at length, filling a whole class period. These types are logical, psychological, historical, popular, and problem. The other types are mainly useful for shorter periods of time; surprise, paradox, series-climatic, and mathematical. The shorter types, can, with advantage, be used as variations of type, to go with the longer types of lectures. In fact, a really effective lecture may include portions of each and every one of the types listed. For simplicity in treatment, however, each will be described briefly as a unit.

The logical lecture comprises the fewest possible pertinent facts each of which is basic to the complete understanding of the subject under consideration. For example, to cover the principles of an electric motor the following items must be clearly in mind:

1. Unlike magnetic poles attract each other.
2. A coil carrying a current is a magnet.
3. A coil wound around a piece of iron is a magnet (electromagnet) while it carries a current.
4. The direction of current in a coil determines the polarity of an electromagnet.
5. The commutator is a switch for reversing the direction of current flow.

The statement and explanation of principles, in a logical treatment, need not and usually do not follow the historical development. For a group of high intelligence, the logical method has much to commend it—a complete picture is presented, and each point contributes to the total.

The active and continuing consideration of the audience to whom the lecture is being presented, may be considered as a start toward the psychological method. To speak in a vein which is understood and appreciated by the various types of individuals present is the essence of the matter. What may be entirely logical and correct to a certain select few, may be much too difficult, or uninteresting to the majority. For this case, as already noted in Section 1, it is important to keep in mind those toward whom the lecture is directed. A sociological approach is likely to be more fruitful, that is, an appeal through the culture patterns.

The historical lecture differs in its presentation from the logical lecture in two ways. First, it usually presents the items in chronological order; and second, it may include the various false theories and unsupported half-truths which are typical of new sciences. It is quite probable that the inclusion of these early accepted items, later disproved, may create an interest in a subject which otherwise might be too condensed for easy understanding.

As an example of a theory which is no longer accepted, two authorities refer to the "magnetism of steel by the sun's rays." The first is a brief paragraph written in 1859 stating that "although the fact is doubted by some experimenters, the weight of testimony appears to support the conclusion that the sun's violet rays possess the power of inducing permanent magnetism, when concentrated by a lens, on steel needles."

The second reference on this subject, actually written in 1833, and published in 1844 devotes more space to this subject, two pages describing the experiments which purported to prove that the sun's violet rays magnetized steel needles, the names of eight philosophers being given as having attained the result. In the latter part of the discussion a pair of experiments are described as having completely disproved the effect, since they went to great pains to examine the magnetic strength before and after exposure to the sun's rays. The experiments were made at different times of the year, at different times of day, the needle was traversed 200 times from center to end, and the complete equipment is described in detail. The conclusion is to "reject a discovery, which for 17 years has at different times disturbed science."

The popular lecture is characterized by the omission of difficult and obscure materials, processes, and theories, but may include portions of all kinds and types of lectures. "Popular" lectures frequently arouse interest of a scientific nature, which otherwise would remain dormant, if the complete and comprehensive treatment were given. A popular lecture is frequently given to an audience of various ages and interest.

In presenting advanced material to an elementary audience, the popular method has much in its favor. To explain nuclear physics in its entirety is impossible to a beginning student. Yet to omit it entirely is to lose an important building block, which later may be of interest. Here a popular treatment of the various fundamentals is indicated.

The use of a "surprise" technique may be used to advantage—but it is of the utmost importance that the desired result be made clear in advance. Here it may be noted that the procedure of the magician is exactly reversed. One of the reasons for the mystification of an audience by a magician is that the result cannot be anticipated simply because it is completely unknown. For example, the magician displays a pitcher of clear water, and to make sure that everyone understands that it is nothing but water he pours out a glassful and drinks it. Then he pours some of it into an empty glass, still it remains clear water. But upon pouring it into a second glass, the color becomes red, and the audience is mystified. Had they known that the contents of the second glass were to become red, some inquiring person might have requested that proof be given that the second glass was empty, to eliminate the possibility of a coloring substance being present.

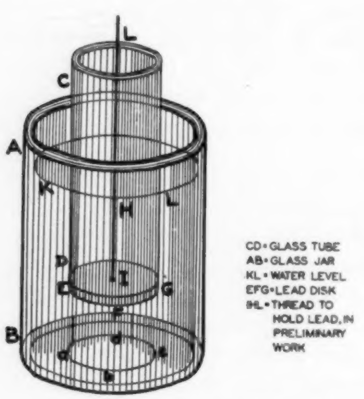
As an example of a different procedure, the physicist takes up an electric flashlight bulb, screwed into a socket and mounted on a base, the base containing a coil of wire, although this fact is not made known at first. The objective is to cause the lamp to become lighted. It is stated that a flashlight battery can be made to light the lamp —and several such cells are available at the other end of the lecture table. The audience knows how a lamp looks when illuminated, and also is reasonably sure that the cells are capable of serving the purpose. Walking toward the battery, with the coil and the lamp carefully held over the table, the lecturer keeps his eyes toward the battery when suddenly, over a concealed coil carrying an alternating current, the lamp lights up; the lecturer, intent on getting to the battery, is surprised (?) to hear the class's involuntary gasp, "It's lighted." Seemingly puzzled, the lecturer examines the lamp and its base, sees nothing amiss, and retraces his steps. Starting again from the end of the table the lamp is dark, again at the same spot the lamp lights up without the use of any battery. Here the explanation can be given—and an important principle of electromagnetic induction demonstrated. The concealed coil is brought forth, and the effect shown again in detail.

While a "surprise" technique has some features in common with that of the "paradox", the latter, to be effective, requires some knowledge of physical principles on the part of the audience. The crux of the matter is that the phenomenon demonstrated seemingly contradicts some well-known and widely accepted physical law.

Hydrostatic demonstrations are among the most used paradoxes in physics. One of these, in a book published in 1806, explains how a lead disk can be made to "swim in water"; Figure II–5 is copied to resemble the original wood-cut. The original text (the two parentheses included in the quotation are all that have been added) states that:

"A piece of lead may be made to swim in water by immersing it to a proper depth, and keeping the water from getting above it. Let CD be the glass tube open throughout, and

E F G a flat piece of lead, exactly fitted to the lower end of the tube not to go within it, but for it to stand upon, with a wet leather between the lead and the tube, to make close work (i.e. a water-tight joint). Let this leaden bottom be a half an inch thick, and held close to the tube by pulling the pack-thread I R L upward at L with one hand, while the tube is held in the other (hand) by the upper end C. In this situation, let the tube be immersed in water in the glass vessel A B to the depth of six inches below the surface of the water at K and then, the leaden bottom E F G will be plunged to the depth of somewhat more than eleven times its own thickness; holding the tube at that depth you may let go the thread at L; and the lead will not fall from the tube, but will be kept to it by the upward pressure of the water below it, occasioned by the height of water at K above the level of the lead. For as lead is 11.33 times as heavy as its bulk of water, and as in this experiment immersed to a depth somewhat more than 11.33 times its own thickness, and no water getting into the tube between it and the lead, the column of water E a b c G below the lead is pressed upward against it by the water K D E G L all around the tube; which water being a little more than 11.35 times as high as the lead is thick, is sufficient to balance and support the lead at the depth KE."



MAKING LEAD SWIM IN WATER

FIGURE II–5

Here the well-known physical fact that lead cannot be made to float in water is apparently contradicted. The analysis affords an excellent opportunity of explaining the fundamental principle of hydrostatic pressure.

An interesting way of giving fundamental principles is to propose the desired effect as a problem, and to ask for facts which will lead to various possible solutions. Each may be written out on the blackboard, and discussed at length, pointing out just how or why each may be expected to serve the desired purpose. For example, the question may be asked, "Is a dog's nose cold because it is wet, or is it wet because it is cold?"

The first thought may be to question the validity of the proposition by asking, "Is a dog's nose always cold and wet?" Those interested in dogs will remember that sometimes a dog's nose is hot and dry, but further questioning brings out the fact that this is probably the case when the dog is not feeling well, and that this is not the general case.

The next items may be, "Do wet objects become cold?" and "Is a wet cloth cooler than a dry one," Here the subject of evaporation and the loss of heat by evaporation and the effect of relative humidity is considered. The outcome, by carefully considering the factors involved, will be that wet objects are cold, with reasonably low surrounding humidity in the air, and that the answer to the first question is that a dog's nose is cold because it is wet.

The series—climatic type of lecture is a powerful type of presentation, but it is restricted to certain classes of physical phenomena. The major idea is to present several demonstrations, each illustrating the same physical law, each succeeding one to be more impressive and striking than its predecessor.

A typical series may be that leading up to the internal combustion gas-engine. Several substances are burned in succession. First a piece of paper is burned in air, then a similar piece is burned in oxygen, the latter showing the increased speed of combustion. Other items in the series may include gases, with varying percentages of air, and the rapidity of burning

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as related to the air percentage is noted. Finally an internal combustion engine model is shown, preferably a working model.

The use of mathematics permits a completely logical approach, analysis, and solution of many physical phenomena. It is, however, debatable whether for the younger audiences such a procedure is completely desirable.

At times, the addition of useful quantitative treatments which mathematics affords, can well be worked out as an accompaniment to the other types of lectures.

THE CORRELATION BETWEEN SCIENTIFIC ATTITUDE AND FACTUAL KNOWLEDGE IN A HIGH SCHOOL CHEMISTRY TOPIC

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What are the vital outcomes of science teaching? What are the deeper values that remain after the factual knowledges have faded from memory? Are they not the mind sets, the tendencies of thinking, the behaviors toward problem situations? In this study it will be attempted to point out the necessity for stressing the development of these attitudes in science teaching.

Most educators agree that it is desirable to inculcate scientific attitudes. But a widespread obstacle to this is the belief that these attitudes can be developed in students as concomitants of other activities. In short, it is believed that scientific attitudes can be induced from a distance. Teachers know only too well that repeated explanations and reviews are necessary to develop informational outcomes. By what strange omission then, is it hoped to make attitudes develop of themselves? Is it that they are so easy for the learner to acquire? Judging by experimental results the very *opposite* seems to be true.

Wrightstone [1] in a study of the correlation between scientific attitudes and intellectual factors found a coefficient of only .45 plus or minus a probable error of .05. This investigation was made on a group of general science students in secondary school. The scientific attitude used as a criterion was "the capacity to choose between a generalization and unfounded beliefs."

Tyler [2] made three somewhat similar studies in elementary college biology at Ohio State University and found the correlation between information and three factors which are in part measures of scientific attitude. The correlation between information and application of principles was found to be .40, between information and interpretation of experiments .41 and between information and formulation of experiments to test hypothesis .46. If these results are a fair sampling of existing conditions, then much further study must be given to develop techniques to inculcate scientific attitudes. The existing data do not indicate that attitudes are more easily learned than facts.

In the present study it was attempted to find the correlation between information and a specific scientific attitude in the field of high-school chemistry. It was necessary to construct two tests, one on information and one on a scientific attitude.

The information test was based on a single topic, namely, "Heating of Metals in Air." This had been studied during the first week of the term. In its develop-

[1] Wrightstone, J. W. "Correlation of Natural Science Beliefs and Attitudes with Social and Intellectual Factors." *Science Education* 18: 10–12, February, 1934.

[2] Tyler, R. W. *Constructing Achievement Tests.* Columbus: Ohio State University, 1934.

ment, the pupils had seen a demonstration where some magnesium had been weighed, burnt, and then weighed again. During their laboratory period they had burnt steel wool in oxygen. They had seen a motion picture film on the historic development of the present theory of burning. In addition they had been exposed to class discussions.

The test of information consisted of five items all of which had been thoroughly covered in the regular class work. No review or announcement had been given to the class about the test. The experimental study was made three months after the topic had been taught. The distribution of the scores, considering the difficulty of the questions, the ability of the students and their familiarity with the work, was that which would normally be expected. The test was marked on a scale of ten points. Two points were allowed for each correct answer. In cases of slight ambiguity in answer only one point was given. Four pupils made perfect scores of ten and one made a score of six. The remaining thirty-five scores fell between this range. The directions for taking the test were given orally since the class was quite familiar with the "fill-in" type questions. The mean of the forty tested students was 8.28. The standard deviation was .77. The test questions are listed below.

INFORMATION TEST

1. When certain metals are heated in air for a certain period of time the product will show a(n).....(1).....in weight.
   (1)................
2. This change in weight is caused by the action of what substance on the metal .....(2).....
   (2)................
3. A noble metal is one that (can, cannot) .....(3)..... be oxidized in air, no matter how high the temperature is.
   (3)................
4. Three noble metals are: silver, gold and .....(4) (4)................
5. If metals are heated to their boiling points or heated slightly below their boiling points for some period of time, they will undergo a physical change called .....(5).....
   (5)................

The scientific attitudes developed in the students was done passively. Most of the time in class was spent on informational learning in preparation for state-wide examinations. When time permitted, historical sketches of the patience, open-mindedness, tolerance and suspended judgment of great scientists were presented. Scientific induction and deduction by pupils was encouraged at all times.

Before the scientific attitude test was constructed, it was necessary to decide whether to include items on several attitudes or whether to limit the entire test to the measure of a single attitude. It was decided to attempt to measure only one attitude, since this would make comparisons of the results simpler to interpret. The attitude selected was from the study of Curtis.[3] After consulting the writings of Karl Pearson, John Dewey and others, Curtis compiled a list of attitudes and had them evaluated by a group of fifty-eight teachers of science in high schools and colleges. On this basis he finally selected five major scientific attitudes, of which one was selected for the basis of the test used in this study. The attitude as reported by Curtis is as follows:

"Conviction of universal cause and effect relations, rendering untenable
(a) Superstitious beliefs in general, as "signs" of "good or bad luck" and "charms."
(b) "Unexplainable mysteries."
(c) "Beats all" attitude, commonly revealed by
  1. Too ready credulity
  2. Tendency to magnify the importance of coincidence."

The items and directions for testing these behaviors and tendencies toward thinking is listed below.

ATTITUDE TEST

On March 13, 1939 (Friday) a laboratory assistant heated a platinum dish for an hour over a bunsen flame at a temperature of 1300° C. When his employer weighed the platinum dish later, he found that it weighed noticeably less

[3] Curtis, F. D. *Some Values Derived from Extensive Reading of General Science.* New York: Bureau of Publications, Teachers College, Columbia University, 1924. p. 41–49.

than it did when he first gave it to his assistant. The boiling point of platinum is 3910° C.

Below are five conclusions. Rate them in order of their relative importance. The least important one is worth 0, next to the least is worth 1, the next is worth 2, the next 3, and *the most important* is worth 4. Put the rating you give in the blank space next to the letter of the conclusions listed.

A. (....) Certain tricks are possible, particularly by certain peoples, where matter can be made to undergo changes that are contrary to the usual laws of chemistry.

B. (....) The heat caused some of the platinum to evaporate into the air.

C. (....) It was not a good day for such type of experiment, since Taurus in the Zodiac shows its strongest influence this time of year.

D. (....) Platinum is a noble metal and therefore its actions cannot be predicted by the ordinary laws of chemical change.

E. (....) Flames of gases make other substances change into gases.

The five questions were assigned a value of ten points. Only those were selected that would indicate the pupils' scientific judgment of the reasons for the change in weight of the crucible. The circumstances were described and five possible causes were listed. The examinee was asked to number the causes from zero to four according to their effective importance. The next step was the construction of the scale for rating the responses. Three experienced teachers of high school chemistry were asked to rate the items. Their combined opinions were used as the basis for grading the questions. The order of importance agreed upon was A-1, B-4, C-0, D-2 and E-3. For each answer that agreed with the key sheet two points were credited, for each that did not no points were given. No part credit was allowed. The Mean on the attitude test was found to be 5.4 and the standard deviation (sigma) was 1.67.

The knowledges needed to answer the attitude test were substantially the same as those required to answer the information test. In this manner it was attempted to limit the influence of the knowledge factor upon the attitude factor. Very often tests purporting to measure attitudes are to a large extent measures of information.

The group used for the investigation consisted of forty students in a single recitation section. They were a select group in that they had all completed at least one year of mathematics and were all "sixth termers" or higher. On the basis of their previous grades in other studies and their I.Q. tests, they could be characterized as "bright." No data other than that furnished by the two tests described above were used in this report.

Both tests were given during the second period of the school day. The pupils were told that the results would not affect their term marks and were asked to give their best efforts. The attitude test was distributed first and ten minutes were allowed for it. After it was collected, the information test was given out and five minutes were allowed for completion. A rest period of about three minutes ensued between the end of the first and the beginning of the second examination. Except for a student or two in each case, the time allowed was quite sufficient. The greatest individual variances in time needed to finish was on the attitude test. Both test question sheets had been mimeographed. Brief oral directions were given with the attitude test since many students were unacquainted with such type of examination.

TABLE 1
ANALYSIS OF FACTUAL KNOWLEDGE ANSWERS

Question No.	No. of Correct Answers	No. of Wrong Answers
1	40	0
2	40	0
3	37	3
4	40	0
5	5*	28*

* Part credit was allowed on seven papers for this question.

TABLE 2
ANALYSIS OF ATTITUDE TEST ANSWERS: NUMBER OF PUPILS SELECTING CERTAIN ANSWERS

Question No.	0	1	2	3	4
A	9	26*	3	1	1
B	2	3	11	17	7*
C	29*	10	0	1	0
D	0	0	2*	9	29
E	0	1	24	12*	3

* Number of pupils whose answers agreed with judges'.

The information test was very simple for the students except for questions 5. On the attitude test questions A and C were answered best. This may have been due to the presence of warning words, such as "tricks" in A and "Taurus in the Zodiac" in C. In B, D and E where no such signals appeared the mortality was higher. In D there were the most disagreements with the judges' opinion. It is interesting in view of the strong similarity in idea of A and D, to notice the disparity in the number of pupils who judged A correctly but missed on D. The questions were inserted to act as a check on each other. These results suggest that pupils' answers may be influenced strongly by key words. In question D, many pupils were evidently taken in by the truth of the first words of the statement, "Platinum is a noble metal," but failed to carefully consider the rest of the statement. The device of placing together an obvious truth with a falsity, in order to pass off the falsity, is one frequently used by inciters of mobs and by swindlers. "Too ready credulity" is one of the convictions that must be rendered untenable by the inculcation of the first of the scientific attitudes proposed by Curtis.

Item B was selected in agreement with the judges' scale by only seven pupils, probably because few of them were familiar with the phenomenon of evaporation of metals. This is indicated by the fact that only five of them knew the answer to question number 5 on the information test, which required a knowledge of the same idea. Since one question on each of the two tests required the same factual knowledge, the correlation coefficient was not markedly distorted.

On item E twelve students agreed with the rating of the judges. Twenty-four were one place below, three were one step above. Only one answer differed by more than a single step. Though this question was not particularly tricky, many did not choose it correctly because errors made in other questions forced them to put this answer into the remaining unanswered positions on the scale.

SUMMARY OF DATA

	Mean	*Sigma*	*Coefficient of Variation*
Factual Knowledge	8.28	.77	9.30
Scientific Attitude	5.43	1.67	30.76

Coefficient of correlation (r) = .45
Probable error of (r) = less than .01.
Regression equation Y = .98X—2.70—1.50

The coefficient of correlation was found by the product—moment method to be .45, with a probable error of less than .01. Since r is so much greater than 4 P.E.'s, it is shown to be very reliable statistically. The regression equation was calculated and found to be Y = .98X—2.70—1.50. From it the probable score a pupil will make on the attitude test (Y), can be predicted if the score of the factual knowledge test (X), is known.

The r of .45 seems to indicate that students may learn information and yet fail to get the desirable attitudes that are potentially available in the same area of knowledge. The r of .45 is in close agreement with the findings of Wrightstone and Tyler, whose studies are mentioned above. Allowances must be made for the differences in test items, subjects, subject matter and other conditions, but one is tempted to believe that the similarity in correlation values may be more than mere coincidence.

The mean and sigma of the factual knowledge test were 8.28 and .77 respec-

tively and for the attitude test 5.43 and 1.67. Since the means for the two tests differed so considerably, the sigmas are not very useful in giving a true picture of the variations in each test from the central tendency. In other words a sigma (standard deviation) of .77 in a distribution of scores whose mean is 8.28, does not have the same significance as a sigma of .77 associated with a mean of, let us say, 4.14. For purposes of comparing two sigmas obtained from different sized means, it is much simpler to find what percentage each sigma is of its mean. This is as though both means were made to equal each other. To quote Mills,[4] "The measure of relative variation most commonly employed is that developed by (Karl) Pearson, termed the 'coefficient of variation', and represented by the letter V. It is simply the standard deviation as a percentage of the arithmetic mean. Thus, $V = \frac{\sigma}{M} \times 100$."

[4] Mills, F. C. *Statistical Methods.* New York: Henry Holt and Company, 1924. p. 165.

By substituting the values obtained from the data of this investigation, the coefficient of variation of the factual knowledge test was found to be 9.30 and that of the scientific attitude test 30.76. It is evident that in this sampling of pupils, much greater individual differences existed in the acquiring of attitudes. Approximately three and one third times less individual difference existed in the learning of factual knowledge. From this data either one of two conditions seems to be true. Either too much time is being devoted to memorization of facts or it is more difficult to instill a scientific attitude than it is to pass on facts. In view of the present philosophy regarding the relative values of knowledge versus attitudes, the teaching implications need no further comment.

THE DETERMINATION OF THE MEANINGS WHICH STUDENTS OF SCIENCE AT DIFFERENT GRADE LEVELS ASSOCIATE WITH SELECTED SCIENTIFIC CONCEPTS[1]

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Educational psychologists contend that there are periods in the life of each individual when certain behavior patterns are developed. Any premature attempts to influence these behavior patterns are a waste of time; any attempts which are made too late necessitate the labor of unteaching inhibitory types of behavior already developed.

This psychological period of "readiness" for learning to read, to write, to count, or to associate meanings with certain concepts is a definite period in the mental growth. When this period of "readiness" is reached, certain types of learning may proceed with maximum efficiency and any attempts to teach certain meanings before the appropriate growth stage is reached are highly inefficient.

[1] Abstract of doctoral dissertation, New York University, 1939.

In order that students of science may be able to develop a fuller understanding of the science concepts utilized in their study of science, it is essential that they acquire adequate meanings.

The purpose of this study is to determine and to formulate a list of meanings which are associated with and essential to a fuller understanding of certain selected science concepts at various grade levels.

A search in the literature reveals several

related investigations. Black studied the difficulties students have in acquiring science concepts; Pruitt formulated a list of science concepts and generalizations in the field of chemistry which are of most distinctive value to man in interpreting his environment. Harrington investigated the correlation between mental age and the development of the concept time; Butler studied the extent to which 7th, 8th, 9th-grade students mastered the group of 63 mathematical concepts which were the findings of Schvoling's investigation; Bagley and Kyte investigated the level at which certain science topics should be taught and the time that should be allotted to the development of these topics; Lammel determined the meanings of 24 of the 45 scientific terms which she secured on the result of an analysis of nine readers in grades 4, 5, and 6.

While these writers dealt with the nature of concepts and the difficulties in acquiring and developing science concepts, they only indirectly revealed the correlation between mental age and the learning of these concepts.

THE PROBLEM

This investigation has sought to determine the extent to which students, at the seventh-, ninth-, twelfth-, and thirteenth-grade levels, showed growth in the number and scope of their knowledges, understandings or meanings associated with certain selected science concepts. No attempt was made to analyze separately the growth in science meanings attributable to science classroom experiences. Rather the composite effect upon growth in science meanings of both the out-of-school science experiences and science-classroom experiences were measured and interpreted.

THE GENERAL PROCEDURE

The general nature of the first portion of this study was to collate, by the analyses of standard general-science textbooks, vocabulary studies, and published statements of science educators, those concepts, or words used as concepts, which were to be considered at the various grade levels.

Those terms, or words used as concepts, which were selected are the following, given in alphabetical order: (1) Electricity, (2) Heat, (3) Light, (4) Mass, (5) Pressure, (6) Volume and (7) Weight.

These seven concepts were selected by the following method:

1. A list of 139 common science words was selected from the first five thousand words in the *Teacher's Word Book*.[2]

2. These 139 common science words were then submitted to a jury of ten science educators. The ten concepts which were designated as "most important" were retained by at least seven of the judges.

3. From the ten terms selected by the science educators, (a) those terms which were classified as at least seventh-grade level words in each of the four vocabulary studies used in this investigation, and (b) those terms which were found to be so used and interpreted as to give and develop scientific meaning in at least nine out of the twelve general-science textbooks analyzed in this study were selected as concepts to be investigated.

The next phase of the study was directed toward the determination of those ideas or meanings which are essential to a fuller understanding of the selected concepts. These associated meanings were determined through the analyses of "free-association" essays which were written by students at the various grade levels indicated.

The test which was used in this study was designed to determine the extent to which students at the chosen grade levels showed growth in the number and scope of their knowledges, understandings or meanings associated with the selected science concepts.

The test was constructed from the ideas or partial meanings determined through the analysis of the "free-association" essays which were written by the 612 students.

[2] Thorndike, E. L. *A Teacher's Word Book of 20,000 Words.* New York: Teachers College, Columbia University, 1931. pp. 134.

These ideas or partial meanings * were used together with non-related ideas to make the various test items.

A test item, together with the direction for taking the test, is here shown:

DIRECTIONS

Below is a series of words, or phrases, which may or may not be associated (related) with these terms called *scientific concepts:*

Electricity	Pressure
Heat	Volume
Light	Weight
Mass	

At the left of the words (below the concept), you are to place a circle around one and only one of the letters:

E .... If the meaning of the word or phrase is ESSENTIAL to a broad understanding of the concept, draw a circle around letter E.

N .... If the meaning of the word DOES NOT HAVE ANY RELATIONSHIP OR DOES NOT HELP YOU TO BETTER UNDERSTAND THE CONCEPT, draw a circle around the letter N.

P .... If the meaning of the word can POSSIBLY broaden your understanding of the concept, draw a circle around letter P.

If you draw a circle around a letter, in whole or in part, and then decide that your response is *wrong,* cross out this letter with an "X" and draw a circle around another which you believe to be the correct one.

EXAMPLE: HEAT

E	N	P	eclipse
E	N	P	round
E	N	P	sun
E	N	P	smiling
E	N	P	fire

Of the total 612 students in typical urban institutions, the tests were administered to 143 students studying science at the seventh-grade level, 157 students studying science at the ninth-grade level, 134 students studying science at the twelfth-grade level, and 178 students studying science in the freshman year at college.

The analysis of the responses to the *concepts* tests provided the raw data of the study. These data were tabulated to show the number and the type of responses made by the students of the various grade levels to the partial meanings of the *concept tests.*

THE EVIDENCE

The thesis proper contains: (1) the frequency and rank of the correct responses to the partial meanings of the various concepts and, (2) the partial meanings and the appropriate grade levels at which students are "ready" to acquire more efficiently these meanings, "readiness" being indicated when at least seventy-five per cent of the students in that grade level made correct associations of these partial meanings with the concepts.

A summary of the findings of this investigation follows:

1. The partial meanings of the selected concepts used in this study are here listed:

TABLE I

THE PARTIAL MEANINGS OF THE SELECTED CONCEPTS USED IN THIS STUDY

Concepts	Partial Meanings	
ELECTRICITY	lighting	negative charge
	telegraph	electron
	household appliances	motor
		used to do work
	ohms	kinetic
	coulombs	force
	flow of electrons	accompanied by heat
	volts	potential
	watts	static
	proton	radio
	current	motion pictures
	transformer	positive charge
	magnetism	telephone
	water-power	wireless
	battery	power
	wind	electro-magnet
	friction	
HEAT	thermometer	oxidation
	body	calorie
	fire	degree
	work done	home
	light	industry
	conduction	radiation
	molecular movement	wave motion
		energy
	convection	metals expand
	sun	warmth

* Instead of the lengthy phrases which the students used in the "free-association" essays, key-words or key-phrases were employed to represent those partial meanings that the students associated with the various concepts.

TABLE I—Continued

Concepts	Partial Meanings	
HEAT	chemical reactions	liquids expand
	electricity	coldness
	friction	
LIGHT		refraction
	travels in straight lines	photography
		travels in waves
		accompanied by heat
	spectrum	
	colorations	growth element
	white	sight
	sun	186,000 miles per second
	moon	
	combustion	lightning
	chemical reaction	light can be bent
		reflection
	electricity	diffusion
MASS		
	occupies space	weight
		gravitational force
	size	
	shape	
PRESSURE		
	weather	altitude
	temperature	atmosphere
	volume	boiling
	caisson	pushing against
	fountain pen	energy
	drinking straw	bombardment
		refrigeration
	humidity	compression
	blood	hydraulic
	under-water	
VOLUME		
	pressure	
	absolute temperature	
	width × height × depth	
	weight	
	space within	
	size of object	
WEIGHT		
	ounces	heaviness
	pounds	occupies space
	grams	lightness
	pull of the earth	molecular arrangement
	attraction of gravity	atomic arrangement
	specific gravity	buoyancy
		displacement
	tons	diet
	density	body weight
	altitude	

2. At least 75 per cent of the 612 students of the various grade levels made correct responses to the following partial meanings for each concept:

(1) *Electricity:* lightning, telegraph, flow of electrons, electron, current, battery, radio, power, electro-magnet and telephone;
(2) *Heat:* fire, sun, degree and warmth;
(3) *Light:* sun, moon and electricity;
(4) *Mass:* none;
(5) *Pressure:* pushing against;
(6) *Volume:* width × height × depth;
(7) *Weight:* ounces, pounds, tons, heaviness, body-weight.

3. Less than 50 per cent of the 612 students of the various grade levels made correct responses to the following partial meanings for each concept:

(1) *Electricity:* potential;
(2) *Heat:* none;
(3) *Light:* none;
(4) *Mass:* none;
(5) *Pressure:* volume;
(6) *Volume:* none;
(7) *Weight:* none.

CONCLUSIONS

On the basis of the responses of the 612 students who were considered in this study, the following conclusions seem warranted:

1. The application of the kind of test used in this study provides a somewhat accurate measure of the number and scope of those knowledges, understandings or meanings associated with science concepts held by students at the different grade levels investigated.

2. There is objective evidence in a large number of cases that either the meanings which were considered in this study are not adapted to the level of the students or that the students have not attained the mental-age level necessary to comprehend adequately and effectively these meanings. This is substantiated by an analysis of the data which shows that, in at least seventy-five per cent of the cases, the meanings were too abstract or remote from the students' interests and understandings as evidenced by the greater number of correct associations which were made by the individuals as their mental abilities matured.

3. The mental-age level should be considered in formulating the partial meanings of the concepts which are to be taught at various grade-levels. This is indicated by the data in this investigation which shows that students do grow in their understanding of science concepts as they increase in mental-age level.

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RECOMMENDATIONS

The following recommendations are made for the improvement of the effectiveness of the present methods of science instruction:

1. The stage of mental maturity or "readiness" for learning should be determined for each pupil.

2. A significant stage in the method of teaching science should be the determination of the interests and partial meanings which can be most effectively acquired at this pre-determined stage of "readiness". It may also be desirable to determine those skills, habits and attitudes which can be acquired during this period.

3. The range and choice of science concepts which are to be taught, at any given grade level, should be those which are not too difficult or whose meanings are not too remote and abstract for the students of the considered mental level.

4. The number and nature of the concepts presented in syllabi for science courses may well be appraised on the basis of the mental-capacity range of the pupils for whom these courses are intended. This appraisal, with resulting modifications in content, would tend to bring the level of instruction to the level of comprehension of the students.

5. Although the investigator recommends the need for determining the stages of "readiness" in order to secure optimum learning conditions for pupils, he also realizes that further research studies are needed to provide means of measuring readiness for any learning sought. Notwithstanding this need, such techniques as were used in this study may serve as helpful aids in attempting to determine those elements which are essential for providing optimum conditions for the learning of far-reaching concepts of science.

CURRICULAR DEVELOPMENTS IN THE TEACHING OF SCIENCE IN PUERTO RICO *

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The divisions of the public school system in Puerto Rico are elementary, secondary and university. This paper is concerned with curricular developments in the teaching of science in the first two levels, namely, elementary and secondary. The elementary school curriculum covers a period of eight years, while the secondary schools offer four-year courses. The continuation schools are incomplete High Schools offering only the first and second years.

The curriculum in both elementary and high schools is similar to that in the United States. The elementary schools however are differentiated into elementary urban and elementary rural schools. The latter follow a two-unit plan, the first of which includes grades one to four, while the second unit includes grades five to eight. A few rural schools in the island enroll pupils from first to eighth grades as the elementary urban schools do.

Many adjustments have been made in the science curriculum to keep pace with the progress in education. Our school system has tried to maintain standards as high as those prevailing in the United States.

HISTORICAL BACKGROUND

In the early days of American occupation, when older theories of education were

* Presented before the Science Section of the World Federation of Education Associations at the University of Puerto Rico, San Juan, August 23, 1939.

generally accepted, there was no provision for a continuous and correlated program of studies in the curriculum. Nature Study was offered in the first four grades of both rural and graded schools. It gave emphasis to the collection, observation and classification of animals and objects and the memorization of terms and definitions. Agriculture was obligatory for all boys in grades six, seven and eight of all urban schools and in rural schools, for all physically able students of both sexes. Special stress was given to gardening. Its main objective was to develop a love for country life and to foster the spirit of cooperation necessary for the solution of the agricultural problems of Puerto Rico.

In the high schools and continuation schools, the program of science was organized around special sciences as follows:

First year high school—Physiography or Botany
Second year high school—Botany or Zoology
Third year high school—Zoology or Physics
Fourth year high school—Physics or Chemistry

Of the sixteen units necessary for graduation from high school one unit of science was required. For example, in the year 1913, the program of science was organized as follows:

First year high school—Industrial and Common Geography
Second year high school—
Botany: first semester
Zoology: second semester
Third year high school—Physics or Chemistry
Fourth year high school—Physics or Chemistry

A course in agriculture was elective for second, third and fourth year students. Instruction was given seven periods a week, three single periods being devoted to theory and two double periods to experimental and actual work in gardening and animal husbandry.

THE NEWER PROGRAM

When it became evident that the course in nature study as offered by the elementary school curriculum did not meet the needs of the pupils, this was substituted by elementary science. This course was organized into units which were centered around generalizations or principles of science as a nucleus. It was the purpose of the committee of elementary school science teachers working under the direction of the general supervisor of elementary science in Puerto Rico, to prepare units intended to broaden the horizon of pupils by presenting problems related to their experience and to increase the scope of the problems as mental capacity develops throughout the grades. The comprehension and enlargement of these generalizations is considered a major objective. Other aims consider the development of a scientific attitude and the acquisition of habits and skills which will help the student to improve his manner of living. This course of study permits the development of an activity program. Teachers and pupils cooperate to enlarge science understandings and try to arrive at correct explanations of diverse phenomena affecting their daily lives. Learning activities such as experimental work, projects, problem-solving situations and field trips are encouraged. Stress is given to the consideration of local environmental problems, attempting nevertheless to present before the pupils a picture of the world in which they live, thus going from the familiar and immediate to the unknown and remote. The course recommends that teaching procedure adapt itself to children's interests, needs and environment so that a dynamic, functional and vital course be the result, and not a mechanized, didactic and rigid program. Teachers are urged to capitalize children's experiences and to associate them with scientific generalizations under consideration in the classroom. There is in this course a marked tendency to integrate the various branches of science. Observations, classification and collection of living specimens are to be considered a means to real and meaningful learning, and not an end. This course of study in elementary school science also

considers teaching techniques, science classrooms and suggestions for its equipment and a bibliography for teachers. The time allotment for the study of science was made as follows:

(a) Urban Schools

Grade	*Minutes daily*
1	15
2	15
3	25
4	25
5	30
6	30
7	30
8	30

(b) Rural Schools

Grade	*Minutes every other day*
1	30
2	30
3	30
4	40
5	40
6	40
7	40
8	40

(c) Second Units

Grade	*Minutes daily*
4	40
5	45
6	45
7	45
8	45

The question whether to use a departmental plan for the teaching of science has been a subject of much debate. For although the departmental plan enables the teacher to become a specialist and enables him to be more accurate in his instruction, on the other hand it tends to isolate science from the other subjects in the program of studies and from all natural contacts.

After a careful consideration of the pros and cons of the question, it was decided that in the lower and intermediate grades science should be taught by the classroom teachers while in the upper grades it would be preferable to use the departmental plan.

In the high schools parallel developments were taking place. Through experience and investigation it was found desirable to change some of the courses offered. There was an exclusion of geography and an addition of general science in the first year of the high school. General science came to provide an opportunity for reaching all that comes nearest the everyday life of the pupil.

Instead of the traditional botany and zoology course, distinct and unrelated, offered in second year high school, a course in biology was introduced in 1927. This was more unified, more practical. Emphasis was placed on the interpretation of the environment. The new course eliminated much memorization, microscopic and theoretical work, it limited the subject matter to the study and interpretation of those phenomena found in the environment of the pupil.

For years the courses in chemistry and physics remained static. There finally appeared a tendency to decrease emphasis on the formal record of laboratory work. To supplement this, workbooks were introduced. They allow the pupils ample time to record all observations in single laboratory periods.

Requirements for both physics and chemistry were planned so as to make them equally suitable for the instruction of the student not going beyond secondary schools as well as for those preparing for college. To this end, the requirements were divided into two parts. Part I contained a minimum list of essential topics. Part II was supplementary and provided for a more extended program.

At the beginning of the school year 1937–1938, it was decided to make a study of all the science courses offered in our high schools for the purpose of determining what revision would be necessary in order to organize a curriculum based on actual needs of the pupil and modern methods of teaching. A committee of teachers of science under the direction of the Supervisor of High Schools was appointed. This committee was composed of teachers of general science, biology, chemistry and physics. The members of the committee met at the Department of

Education's offices during school hours and substitute teachers were furnished by the Department of Education.

Textbooks were ordered from different publishing companies and were available for consultation. Various other sources of information such as courses of study from many cities in the mainland, articles in education magazines, recent researches, and suggestions from various teachers were also utilized.

It was agreed to center the work of the committee around the general aim of education: the enrichment of life through participation in a democratic social order. This aim was analyzed into specific aims based on the reports of the National Society for the Study of Education in its Thirty-First Yearbook.

In terms of outcomes, it was decided that a course in science would attempt to develop:

1. Scientific attitudes.
2. An understanding of those principles or generalizations which pupils may use in the solution of such problems as may arise in their lives.
3. Skill in the use of the scientific method of thinking.

The unit plan of organization was adopted. Studies were made to determine which are the most important principles that should be considered in each course and with these as a starting point, the various members proceeded to work separately.

Tentative courses of study have been prepared. It is not presumed that these courses will meet all difficulties that arise in the teaching of science, but it is believed that they will be of real help in providing young people with a program contributory to the aim of education—life enrichment.

In the various suggested activities included in each course, opportunity has been given to pupils for exploration, and ample provision has been made for individual differences.

Believing that a reliable course of study cannot be made by a group of people meeting around a table, but by the collective experience of all the teachers in the field, these tentative courses have been sent to various selected high schools on the island to be tested and criticized. The work so far is rather incomplete and we anticipate that it will undergo revision as experience justifies it.

PREPARATION OF TEACHERS

The problem of providing properly trained teachers of science for the elementary grades was for several years a difficult one to solve. The handicap was gradually eliminated by the following means:

1. Teachers who were high school graduates were advised to take a course at the University of Puerto Rico on Methods in Elementary Science.
2. Teachers who were not high school graduates were advised to enroll in evening classes in general science offered by the Bureau of Extensions and Examinations.
3. Superintendents of schools and school directors organized weekly or monthly meetings presided over by a high school teacher of science or some person properly qualified. These meetings aimed to discuss both contents and methods in the teaching of elementary science.
4. Through the Bureau of Extensions and Examinations some teachers were able to take courses in such sciences as chemistry, physics, biology and general science.
5. Through the use of a bibliography which was prepared here other teachers were able to study for themselves the fundamentals of the various branches of science. By these means teachers became better prepared in the subject matter and in the fundamental principles of science.

In our high schools, the story has been similar. Teachers having no aptitude or inclination for teaching science were for years attempting to teach courses in these subjects. On the other hand teachers well prepared in certain subject matter branches of science were teaching classes in other branches wherein they had little or no knowledge. The Commissioner of Education is at present trying to correct instances of such maladjustment. Teachers are being appointed on the basis of their qualifications, and the newly appointed teachers, in all probability, will teach the branches

of science in which they have the better training.

At present, all teachers of science in our high schools are graduates of accredited colleges and universities and have majored in science. A large percentage have done and are now doing graduate work. Science teachers are also required to have a minimum of fifteen hours in education so they may acquire an adequate background of educational principles, theory and practice.

EQUIPMENT

The chief problem confronting elementary schools is that of having well equipped laboratories. In most cases the equipment is purchased with funds provided by the municipalities. Most elementary urban schools have a special room equipped for laboratory purposes.

In our high schools, science has always been allotted a major portion of the money provided by the Department of Education. Laboratory rooms, especially those used for chemistry and physics are, as a rule, well equipped. Science work has been made safer by substituting Bunsen burners for the old alcohol lamps.

The hurricane which swept the island on September 13, 1928, destroyed much equipment, thus creating very pressing demands. These however, have been gradually satisfied through new purchases.

Due to the salty sea breeze that blows over the island, the keeping of laboratory material in proper shape is a constant problem. Iron and steel instruments rust almost overnight, and teachers must constantly be on the alert to keep them properly oiled. Very excellent work in this respect was done by Mr. H. A. Martin in his capactiy as general supervisor of high schools. He gave close attention to the inspection of all laboratory equipment, checking the care it received.

In order to avoid waste of money buying unnecessary material, the equipment in science was made standard. A copy of such standardized equipment specifications is sent to each science teacher and teachers are by this means able to know what material is needed.

VISUAL EDUCATION

In 1928 visual instruction was introduced for the first time in our curriculum at the University High School. A few years later the Depratment of Education through its Bureau of Adult Education and Extension Activities purchased thirty five film projectors. These have been distributed among the various school districts of the island. A list of films for classroom activities has been prepared in catalogue form. Full information including subject, type (silent or sound), title, number of reels, length, catalogue number and page on which to find data on content is given. To obtain the films, teachers and superintendents on the island must fill out an order form. This is sent to the Bureau and films are furnished free of charge. One lantern has also been purchased. Several schools on the island have, of their own initiative, purchased lanterns for their own use. The work on visual instruction has been most effective so far. It has helped the science teacher in his aim to impart to subject matter, both meaning and vitality.

From the foregoing we come to the following conclusions and subsequent recommendations:

In spite of the recommendations in courses of study that more stress be laid on general principles considering units on animal and plant life and the physical sciences, our general teaching practice in science gives more emphasis on direct learning of subject matter and on the acquisition of detailed items. Learning will be enriched if a consideration is made of such concepts as the interrelationships between man, plants and animals, of the earth's position in relation to other heavenly bodies, of the effect of climate on living

beings and on the surface of the earth, of man's adaptation to his environment and of his use of the earth's natural resources. More than 75 per cent of our high school graduates will not need any biological or natural sciences as such, for their activities in life. Furthermore, a great percentage of pupils from the elementary school will not stay in school longer than the sixth or eighth grades. Nor more than 20 per cent will enter the College of Science and Liberal Arts, or the College of Engineering where they may continue the study of advanced science courses.

More integration should exist between this elementary school science and High School science. True, the elementary school offers a continuous and progressive science program, but a gap exists between this school and the secondary school. It is to be expected that in the near future this gap will be closed. High school teachers should be cognizant of the Elementary School program and Elementary School science teachers should be familiar with the aims, selection and organization of content, teaching techniques and other problems of High School science.

Experimental studies on grade placement of science concepts are needed for elementary and high school science.

More correlation or integration of the various branches of science taught in the high schools should exist. There should also be a wider correlation between science and the other subjects in the school program.

A more varied program of studies in our high schools providing for individual differences: interests and abilities is needed. Under present conditions many high schools offer chemistry one year and physics the next. When biology is offered, for example, all students cannot be accomodated and as a result high school students with only one science (Biology, Physics or Chemistry) are being graduated. It is our opinion that high school graduates should be required to take at least two such sciences. The course in General Science should be required of all first-year students and this should be considered as an orientation course emphasizing attitudes, scientific organization and scientific methods of investigation.

It is our recommendation that a record be kept on the various studies and experiments performed, with the purpose of modifying science instruction both in elementary and high schools. The revision of courses of study, the basis for selection of textbooks, the criteria for selecting content of courses of study, *etc.*, are subjects of great interest to all science teachers. If such records had been kept, the information which we now offer could be backed by positive evidence gathered in the field of education from our own schools.

In relation to the preparation of teachers of science we rceommend:

That the course for the Teaching of Elementary Science continue to be offered in the College of Education during the academic and during the summer course so that teachers who have not taken it may avail themselves of this opportunity. We must say however, that with the expansion of science in the elementary schools of Puerto Rico, the training of elementary science teachers should be given more consideration by the College of Education. A semester's course of three hours a week is insufficient for the preparation of teachers whose only background consists of one or two sciences studied in the High School. It is difficult and practically impossible for this Science Education course to consider properly such vital items as: aims, methods and tests in science teaching, selection and organization of content, equipment of science classroom, besides the study of principles necessary to the interpretation of the natural phenomena of the environment surrounding the child. These teachers in training have no opportunity to manipulate materials of elementary science, nor to con-

sider frequent excursions or laboratory work, nor have they the time to familiarize themselves with the various science texts and courses of study of value to them in their science work. This course will also be of more value if it is provided with a proper science classroom with adequate equipment which will permit the students to familiarize themselves directly with scientific techniques. If the semester's course were to consider only the teaching of science for the Primary Grades and another semester for the teaching of science in the intermediate grades, for example, more efficient science teachers would be the result. Unquestionably these teachers need not only a professional course, but general college science which will provide them with a wider outlook.

A similar professional course in Science Teaching for the High Schools should be offered to prospective High School science teachers.

Many prospective teachers in the College of Education of our University major in one of the sciences, say Biology, Chemistry or Physics, but they are not required to take even the elementary courses in the other sciences. For example, a "major" in Biology and "minor" in Physical Education is not required to take any course in Chemistry or Physics.

A teacher of science cannot be successful unless he has a solid knowledge of other sciences as a background. Furthermore science teachers in most of our High Schools are required to teach at least two different sciences because the program does not have enough classes in one subject to take up all the time of a regular teacher.

Students of the College of Education preparing themselves to teach High School science should be required not only to have a Major in Science, but a minor in another sceince or Mathematics.

The University should offer regularly courses in Physics, Chemistry, Biology, Geology, Astronomy, Physical Geography.

Efficient teachers in service should be given the right to sabbatical leave so that they may use it to do research, postgraduate work, or to travel. In this case the teacher should be entitled to receive at least 50 per cent of his yearly salary. This would no doubt avoid the natural stagnation that results from year after year of teaching with no appropriate means for improvement.

It will benefit our students much more if teachers give emphasis to the development of a problem-solving approach. If it contributes to the individual's comprehension of his immediate problems, if it will aid him in his role as a consumer, if the cultural aspects of science make provision for a better use of his leisure time, elementary and high school science will be more meaningful to the majority of our students.

The use of simple, practical apparatus that can be seen and understood in operation is to be preferred to delicate and costly apparatus. The latter is to be recommended solely for demonstration purposes but not for individual experimentation on the part of the students. The use of simple and possibly home made apparatus will not only improve the teaching procedure but will encourage students to construct such apparatus and to make further investigations in their homes.

Textbooks with material and subject matter related to our own environment are urgently needed. The Physics and General Science textbooks give too much emphasis and space to the discussion of artificial heating and ventilation, information which is useful in the United States but not necessary for the children in our schools. The textbooks in Biology and General Science consider animals, plants, soils, etc., but do not mention those which usually interest and are known by our children. When studying birds the child finds in his book those typical of regions from the continent and no mention is made

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of those birds that are making nests and singing in the trees just outside the schoolhouse. We recommend that the publication of such books adapted to our needs, both for the elementary and high schools be encouraged and paid for by our Department of Education.

Our schools consider very little extensive reading of scientific magazines. A science class should receive at least one monthly magazine to keep students and teacher up-to-date in the progress of science. Nowadays it is practically impossible for the teacher to collect money for the subscription fee from the different members of the class.

Our science teachers are carrying such a teaching load and must participate in so many classroom activities that it is practically impossible for them to undertake activities such as science clubs, museums, field trips, research, *etc.* We know that this heavy program is due to our exceptional overpopulation, and that our educational authorities are doing the best they can to remedy this difficulty. Under the present conditions of a limited number of teachers and buildings, and of a budget that does not permit any increase of expenditures, we point out the difficulty and it is to be hoped that some time our teachers will be in a position to give more attention to individual differences and interests and will utilize such findings in modifying science programs and in constructing their own teaching units.

TO OUR READERS

Since its first issue in May, 1939, *Science Education* has maintained its policy of an open forum for subscribers. No special cliques, personal ambitions, or vested interests have been served. Nor will they be under the present editorial board. The journal is your medium of expression to science teachers and school administrators in all sections of the country.

Better science teaching at all school levels was the original purpose of *Science Education.* This purpose has not changed. Improvement of the magazine demands your best contributions and also your further assistance in giving us leads to the challenging work and ideas of others. Will you send the editor one or more of the following:

1. An editorial of 300 to 500 words on some burning problem related to the teaching of science.
2. A description of a new program of study in science for the elementary school, the junior high school, the senior high school, the junior college, or the teachers college.
3. A description of a new course in science which you have formulated.
4. An outline of a unit in science which you are enthusiastic about.
5. A report of an investigation which you have recently completed.
6. A description of a classroom technique, demonstration, device, test, or other "trick of the trade" which other teachers would like to try.
7. An assembly program or a science play written by you or your students.
8. A report of an exhilarating program of your science club.
9. A discussion of an outstanding project or activity done by one or more of your students (and written by the student).
10. The name and address of anyone you know or have heard whom we should contact for a contribution to the pages of future issues of the journal, whether in the field of science content or science teaching.
11. A brief statement of your ideas concerning ways to improve the journal *for you.*
12. A request for our "Suggestions to Authors."

Editorials and Educational News

SEVENTH ANNUAL MEETING OF THE AMERICAN SCIENCE TEACHERS ASSOCIATION

Associated with the American Association for the Advancement of Science
Columbus, Ohio, December 27 and 28, 1939

Officers

President—W. L. Eikenberry, State Teachers College, Trenton, New Jersey.

1st Vice-President—Harry A. Cunningham, Kent State University, Kent, Ohio.

2nd Vice-President—Homer W. Le Sourd, Milton Academy, Milton, Massachusetts.

Secretary—Deborah M. Russel, State Teachers College, Framingham, Massachusetts.

Treasurer—Louis J. Mitchell, Dansville Central High School, Dansville, New York.

PROGRAM

Board of Directors—Wednesday, December 27, 6:30 P.M. Dinner and Conference (Room 1337, Deshler-Wallick Hotel).

Morning Session—Thursday, December 28, 9:30 A.M. Hall of Mirrors, Deshler-Wallick Hotel.

Presiding—W. L. Eikenberry.

9:30–10:15—"The Contribution of Nieuwland to Synthetic Rubber," Thomas Midgley, Jr., Chairman of the Board of Directors of the American Chemical Society, Worthington, Ohio.

10:20–11:05—"The Anti-Scorbutic Vitamin," Charles Glen King, Professor of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania.

11:10–12:00—"A History of Science in Mural Painting." Fifty-two scientists and a classification of living things. This five year project by Elmer E. Taflinger, mural painter, and Robert Lovell Black, science teacher, will be presented and briefly explained by Robert Lovell Black, Instructor of Biology, Emmerich Manual Training High School, Indianapolis, Indiana.

Luncheon Meeting—Thursday, December 28, 12:30 P.M. (Hall of Mirrors, Deshler-Wallick Hotel.)

Presiding—W. L. Eikenberry.

Address—"The Role of Chance in Discovery," Walter B. Cannon, President of the American Association for the Advancement of Science, Harvard University, Cambridge, Massachusetts.

Afternoon Session—Thursday, December 28, 2:00 P.M. (Hall of Mirrors, Deshler,Wallick Hotel.)

Presiding—Harry A. Cunningham.

2:00–2:15—Announcements.

2:15–2:50—"Outstanding Problems of Junior Academies and Possible Solutions," Anna Augusta Schnieb, Professor of Education and Psychology, Eastern Kentucky Teachers College, Richmond, Kentucky.

2:55–3:25—"Science in General Education at the College Level," Lloyd W. Taylor, Professor of Physics, Oberlin College, Oberlin, Ohio.

3:30–4:00—"Brooklyn Botanic Garden's Cooperation with Public Schools," C. Stuart Gager, Director, Brooklyn Botanic Garden, Brooklyn, New York.

4:00–5:00—Business Meeting. Reports of Committees, Election of officers.

Board of Directors—Thursday, December 28, 7:00 P.M. Deshler-Wallick Hotel.

Exhibits—There will be an exhibit by the Du Pont Company to be used in connection with Mr. Midgley's paper on synthetic rubber. Another exhibit will be presented in connection with the paper on Junior Academies.

MOTION PICTURES ON HUMAN RELATIONS

The Commission on Human Relations of the Progressive Education Association has announced the availability for rental, for educational purposes only, of a series of 16-mm. sound films made from excerpts from famous photoplays.

Among the many titles are the following of especial interest to science teachers:

Arrowsmith—13 minutes, 487 feet.
Good Earth (locusts)—14 minutes, 489 feet.
Story of Louis Pasteur (anthrax)—17 minutes, 612 feet.
Story of Louis Pasteur (hydrophobia)—18 minutes, 652 feet.

These excerpts have been edited by the Commission and accompanying study material is provided with each film rented. The use of the films is legally restricted to

regularly established classes or study groups in educational institutions and organizations. Applications for rental must be made on a legal form provided by the Commission. Rental charges for a period of two weeks are six or seven dollars for each film. For longer periods the cost is slightly more. Additional information and application blanks may be obtained by addressing the Commission on Human Relations, Progressive Education Association, Room 3847, Rockefeller Plaza, New York City.

PHOTOGRAPHY CONTEST

Youthful photographers throughout the United States are being invited to exhibit their prints at the annual Scholastic Salon of Photography to be held by The American Institute Science and and Engineering Clubs from February 17th to 25th, 1940.

This Salon will be the third national exhibition of photographic work of junior and senior high school students and camera club members. Four hundred prints representing all sections of the United States were exhibited at the Salon last spring.

Under the supervision of a committee representing The Institute and the Camera Clubs in many large schools, the Salon is conducted on the same basis as are the great professional shows. Only those pictures which, in the opinion of the judges, meet the standard of technical and artistic skill will be admitted for exhibition.

Awards will be made by a judging committee of professional experts, and there is the strong likelihood that prize winning prints will find their way to the World's Fair in 1940.

Members of camera clubs everywhere and junior and senior high school students interested in good photography are urged to write The American Institute, 60 East 42nd Street, New York City, for the Salon booklet which gives information, rules and an entry blank. The closing date for entries is January 31st, 1940.

BUREAU OF MINES FILMS

The Bureau of Mines, Department of Interior, announces several new films in 16-mm. size, available for transportation charges through the Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pa.

The latest technical advances in the manufacture of gasoline and lubricating oils are shown in three recently revised films:

No. 99, "The Story of Gasoline."
No. 120, "The Story of Lubricating Oil."
No. 151, "Automobile Lubrication."

Another film, made on three reels, entitled "Fabrication of Copper," depicts the production and use of this important industrial metal.

Special descriptions of these films may be had from the Division of Information of the Bureau.

Abstracts

ELEMENTARY SCIENCE

PALMER, E. LAURENCE. "Creeping, Sprawling, Climbing Plants." *Cornell Rural School Leaflet* 32 : 3–32; March, 1939.

This illustrated leaflet has the following sections: (1) sprawlers and creepers, (2) flower-garden sprawlers, (3) pasture and lawn sprawlers and creepers, (4) sprawling house plants, (5) how plants occupy marshes and open water, (6) climbers, and (7) some of the uses of climbers. —C.M.P.

BLOUGH, GLENN O. "Studying Our Natural Resources." *The Instructor* 58 : 41–48; May, 1939.

This elementary science unit presents an overview, objectives, suggested approaches, activities, assembly programs, suggestions for pupil discussions, suggested lessons, and bibliography for various grade levels. —C.M.P.

BRAUER, OSCAR L. "Metals and Their Origins." *Science Guide for Elementary Schools* 5 : 1–41; December, 1938.

This bulletin discusses composition of the earth's crust, the chief metals, alloys, and metals in California. It has suggestions for teachers, a bibliography, and a useful appendix.

—C.M.P.

GRAVES, GEORGE W. "National and State Forests and Parks." *Science Guide for Elementary Schools* 5 : 1–60; November, 1938.

This bulletin discusses national parks and forests, their histories, values, and locations.

—C.M.P.

DUNCAN, CARL D. "Termites." *Science Guide for Elementary Schools* 5 : 1–31; April, 1939.

This is an excellent number, suitable for either elementary science, general science, or biology. The following are the major topics discussed: (1) California species of termites, (2) termites in the school science program, (3) termite castes, (4) food of termites, (5) nest construction, (6) enemies of termites and colony defense, (7) the founding of new colonies, (8) termites and human welfare, and (9) bibliography. —C.M.P.

DAVIS, C. G. "Ants." *The Grade Teacher* 56 : 32–33, 67; June, 1939.

This is a unit in elementary science on ants. It describes their structure, habits, manners, customs, et cetera. Methods of making various types of artificial ant nests in the school room are described. —C.M.P.

BUSS, FRED E. "Streams and Their Valleys." *Science Guide for Elementary Schools* 5 : 1–53; February, 1939.

The theme of this pamphlet is the stream and its features as an element in the environment of the child. Major divisions of the treatise are: (1) streams and their stories, (2) economic aspects of streams, (3) suggestions to teachers, (4) glossary, and (5) bibliography. —C.M.P.

HOWE, J. WENDELL. "Domestic Mammals." *Science Guide for Elementary Schools* 5 : 1–35; January, 1939.

This bulletin discusses mammals as to domestication, groups of domestic animals, carnivorous animals, herbivorous animals, and cruelty to animals. There is a curriculum unit on domestic animals and a bibliography.

—C.M.P.

JENKINS, FLORENCE K. "Our Birds." *The Grade Teacher* 56 : 28, 71; May, 1939.

This is a short elementary science unit for primary and intermediate grades. Included are objectives, questions, methods of correlating with other subjects, and brief references.

—C.M.P.

HAVER, ELLA M. "A Unit on Vertebrate Animals." *The Instructor* 48 : 24, 79; October, 1939.

This illustrated unit for the upper grades lists: objectives, approach, classification of vertebrates, and conclusion. Fish, amphibians, reptiles, birds, and mammals are discussed under the headings: problems, adaptations, and experiences.

—C.M.P.

SECONDARY SCIENCE

FRANK, O. D. "Suggestions for Spring Field Trips." *Biology Briefs* 2 : 17–18; April, 1939.

The author presents means of gaining interests in field trips, need for teacher preparation of field trips, and a list of field trips suitable for springtime.

—C.M.P.

ANONYMOUS. "Life In the Past." *The Science Leaflet* 12 : 27–30; April 27, 1939.

Most of the life of the past was quite different from what it is today, but became extinct for a number of reasons. Some of these causes of extinction were geological and some were biological. —C.M.P.

KAYE, PAUL I. "Shadow Projection"; Spector, Aaron and Feldman, Alexander, "The Doppler Effect"; Feldman, Alexander, "Humidity and Invisible Water Vapor"; Yacknowitz, Samuel B., "A Direct Method of Demonstrating the Presence of a Vacuum in a Torricelli Barometer." *The Science Classroom* 18: 1, 4; May, 1939.

This is a continuation of the report of details of science teaching demonstrations presented before the New York City General Science Teachers Association on January 6, 1939.

—C.M.P.

BUSH, MARION M. "Suggestions for Teaching a Unit of Work on Silk and Rayon." *The Science Leaflet* 12: 1106–1113; April 20, 1939.

This is an illustrated article on different tests on rayon and silk.

—C.M.P.

MANDEL, JAMES. "Cancer and the Schools." *The Teaching Biologist* 8: 105–107; April, 1939.

One of every 7.4 deaths is due to cancer. The author makes a plea for presenting the basic facts to high school students. A presentation outline is included.

—C.M.P.

LOCHIE, J. ANNABEL. "Notes on Cotton and Linen Fabrics." *The Science Leaflet* 12 : 1181–1186; May 4, 1939.

This article discusses buying and tests on cotton and linen fabrics.

—C.M.P.

ANONYMOUS. "Life in the Future." *The Science Leaflet* 21: 1175–1177; May 4, 1939.

Life will probably continue for an inconceivably long time. Man is a relatively constant and the most adaptable species and hence is most likely to survive cyclic changes in temperature and other environmental conditions.

—C.M.P.

WAILES, RAYMOND B. "Hints for Beginners in Amateur Chemistry." *Popular Science Monthly* 134 : 194–197, 234; June, 1939.

A series of experiments, devices, and hints for the beginner in chemistry are described in this interesting article.

—C.M.P.

WALLING, MORTON C. "Everyday Jobs for Your Microscope." *Popular Science Monthly* 134 : 200–203, 236; June, 1939.

Many interesting experiments such as examining the edge of a razor blade, the material of a new suit, the parts of a radio set, gems *etc.* are described in this article.

—C.M.P.

ALLEN, ARTHUR A. "Stalking Birds with a Color Camera." *The National Geographic Magazine* 75 : 777–789; June, 1939.

This is a splendid article with seventeen most attractive photographs, fourteen of which are color close-ups, by one of America's leading authorities on birds.

—C.M.P.

WALLING, MORTON C. "Looking at Shells with Your Microscope." *Popular Science Monthly* 135 : 194–197, 234–236; July, 1939.

This illustrated article describes the process of preparing shells for microscopic observation. A description of the appearance of some shells under the microscope is given.

—C.M.P.

WAILES, RAYMOND B. "Fun with Black Light for Home Chemists." *Popular Science Monthly* 135 : 188–191, 232; July, 1939.

Interesting experiments, odd effects and different stunts that depend upon fluorescence, are described in this article.

—C.M.P.

ANONYMOUS. "Science in Easy Tests." *Popular Science Monthly* 135 : 192–193; July, 1939.

The following science experiments are illustrated and described: (1) freaks of surface tension, (2) color vision changes as the light fades, (3) differences in liquid viscosity, (4) toy mouse demonstrates resonance, and (5) sometimes you see things by not looking at them.

—C.M.P.

PLATT, H. HENRY. "Science for Fun." *Journal of Chemical Education* 16 : 265–267; June, 1939.

This article describes the Science Club work of Elizabeth Peabody House, Boston, Massachusetts. At last year's science fair one hundred fifty boys and girls had exhibits. They all agree "science *is* fun."

—C.M.P.

COLLEGE SCIENCE

LATON, ANITA D. "Learning to Use Science in Managing Our Lives." *Teachers College Record* 40 : 284–296; January, 1939.

The Bureau of Educational Research in Science had two original purposes: (1) the drawing out from the findings of science those ideas having greatest significance for human beings, and (2) the experimental investigation of how children may be helped in school to explore some of these ideas with the greatest profit to themselves in the management of their lives. Utilizing available studies in education and phychology, the Bureau has worked out certain teaching units for experimental try-outs in

schools. The techniques to be used in these units are described in this article—learning activities and instruments for the study of learning and for evaluation.

—C.M.P.

FITZPATRICK, F. L. "Implications of Our Knowledge Concerning Biological Production and Control." *Teachers College Record* 40 : 297–307; January, 1939.

The thesis of biological production and control is to apply biological knowledge in the solution of problems which are related to the physiological and economic welfare of mankind. These problems are both individual and social. The article discusses some of these problems such as control of natural enemies, control of competitors, and so on.

—C.M.P.

POWERS, SAMUEL RALPH. "Improvement of Science Teaching." *Teachers College Record* 40 : 273–283; January, 1939.

The major thesis developed in the first part of the article is that there has been a growing discontent with education in general and more specifically with the part that science has in education. The more important shortcomings of science, some of which can be remedied, are listed. To meet these needs, not only are changes needed in the science curriculum, but science teachers themselves need a more liberal conception of science. An outline of the content developed by the Bureau is presented.

Consideration is given to the teaching and learning of this content. The best approach would seem to be by the development of broad science generalizations, a few of which are listed in this article, and one of which is illustrated.

Science teaching is particularly concerned with developing the following traits and capacities in individuals: (1) specific information and specific skills, (2) generalized insights, (3) careful and critical methods of thinking, (4) attitudes and appreciations, and (5) an intelligent and workable philosophy for living in a modern world and in a democratic society.

—C.M.P.

POWERS, SAMUEL RALPH. "Study and Research in the Improvement of Science Teaching." *The Advanced School Digest* 4 : 1–5, 20; December, 1938; January, 1939.

This article briefly summarizes certain studies (with one exception), done at Teachers College relative to processes of teaching and learning and with the selection of valid curriculum material. These studies are those by Powers, Black, Horton, Laton, Craig, Curtis, Clemensen, Haupt, and Arnold. The work and studies of the Bureau of Educational Research in Science are briefly described. Two interpretative generalizations developed by the Bureau are analyzed.

—C.M.P.

REED, RUFUS D. "The 1937–38 College Chemistry Testing Program." *The Journal of Chemical Education* 16 : 184–190; April, 1939.

This is the third report of the Testing Committee of the Division of Chemical Education. The data in this report is based on 9,542 cases from 149 colleges. As usual, great variations exist between different colleges, the best 10 per cent in one college would be the lowest 10 per cent in another college. Students in engineering colleges rank highest; in agricultural colleges, lowest. Among vocational groups, rankings were as follows: (1) college teaching, (2) engineering, (3) medicine, (4) secondary teaching, (5) agriculture, (6) business, and (7) home economics. Students with high school chemistry do better than those not having had high school chemistry. Men do better than women.

—C.M.P.

SEARS, PAUL B. "Life Science in the New General Education." *Teachers College Record* 40: 340–352; January, 1939.

This article discusses the place of biological science as a part of general education. A list of generalizations for possible use in biological survey courses is presented. These generalizations relative to the two following themes: (1) the inter-relations of living things, and (2) human growth and development. Objectives for such a course are listed as follows: (1) verbal knowledge, (2) verbal analysis of concrete situations, (3) interpretation of symbols in terms of actions, (4) actions in terms of observed realities, and (5) less tangible but fundamental changes which might be expected.

—C.M.P.

ROLLER, DUANE. "The Physical Sciences and General Education." *Teachers College Record* 40: 329–339; January, 1939.

The place of physical sciences in general education is specifically developed in this article. A selected body of content centering about certain generalizations in physical science which were formulated in the Bureau of Educational Research in Science is included.

—C.M.P.

PILLEY, JOHN G. "Scientific Method." *Teachers College Record* 40 : 317–328; January, 1939.

This article presents the thesis that the diffusion of scientific attitudes is the primary concern of science teaching. The methods and content whereby this may be more readily done are briefly discussed.

—C.M.P.

FURNAS, C. C. "Man's Use of Materials and Energy." *Teachers College Record* 40 : 308–316; January, 1939.

The need of better integration between the different sciences and between the sciences and other courses is emphasized. Conservation is an important problem but not as pressing as

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that of technological employment and the social implications of the use of science.

—C.M.P.

DEGERING, ED. F. "The Use of Semimicro-Methods in Undergraduate Instruction." *Journal of Chemical Education* 16 : 276–277; June, 1939.

Results at Purdue University seem to indicate that semimicro-methods are superior to the usual macro-methods in the following respects: (1) the student learns to do more correctly, (2) he is compelled to sense more accurately, (3) he is encouraged to think more clearly, (4) he is inclined to record more intelligently, (5) the cost of his working space is only one-half as much, (6) the cost of his apparatus is reduced to about one-half as much, and (7) the cost of his chemicals is only ten to fifty per cent as much.

Semimicro-methods are rapidly replacing macro-methods in college chemistry.

—C.M.P.

MACPHAIL, ANDREW H. AND FOSTER, LAURENCE S. "Placement in Beginning Chemistry Courses at Brown University." *Journal of Chemical Education* 16 : 270–273; June, 1939.

Beginning students in chemistry are placed in one of two sections as determined by their scores on the Iowa Chemistry Training Test and the Sones-Harry Mathematics Test. Results have been very satisfactory. Such placement reacts to the benefit of individual students in each section.

—C.M.P.

EDUCATION

ANONYMOUS. "Salaries of School Employees, 1938–1939." *Research Bulletin of National Education Association* 17 : 67–95; March, 1939.

School salaries by states and for some cities, for elementary, junior high school and senior high school teachers for 1938–1939 are given. There is a slight uptrend in salaries.

—C.M.P.

ANONYMOUS. "Tax Legislation Affecting State School Revenues, 1934–1938." *Research Bulletin of National Education Association* 17 : 100–155; May, 1939.

Divisions of this report are as follows: (1) tendencies in state tax legislation, 1934-1938, (2) income taxes, (3) general sales taxes, (4) selective sales taxes, (5) chain-store taxes, (6) inheritance, estate, and gift taxes, (7) severance taxes, (8) corporation taxes, (9) license taxes, (10) property taxes, (11) tax surveys and commissions, and (12) sources of tax information.

—C.M.P.

FOSDICK, RAYMOND B. "A Review for 1938." *Report of The Rockefeller Foundation* 72 p; 1939.

This is the annual report of the president in which is reviewed the chief activities of the foundation. Much interesting science information is included. —C.M.P.

SYMPOSIUM. "Civil Liberties." *Building America* 4 : 1–31; May, 1939.

This issue traces through pictures and discussion the development and growth of civil liberties in this country from early colonial times to the present. —C.M.P.

SYMPOSIUM. "The Radio In Education." *The Phi Delta Kappan* 21 : 297–358; March, 1939.

This special number on radio in education has the following articles and authors: (1) The production and use of educational disc transcriptions, by Francis F. Powers, (2) Radio as a teaching technique by H. M. Buckley, (3) Preparation of programs, by H. Clay Harshbarger, (4) The radio and child development, by John E. Anderson, (5) Civic broadcasting within states, by Boyd F. Baldwin, (6) Democracy and the broadcaster, by Thomas Freebairn Smith, (7) An adventure in radio, by C. C. Trillingham, (8) Evaluating the production and use of school broadcasts, by J. Wayne Wrightstone, (9) Psychological Factors of Education by radio, by Willis L. Uhl, (10) The role of the college radio station, by Harold B. McCarty, (11) Audio aids used economically and effectively, by Roy W. Fredin, (12) The radio world is yours, by William Dow Boutwell and Dorathea Seelye, (13) Developing critical listening, by I. Keith Tyler, (14) Vocational training aspects of radio instruction, by Ellsworth C. Dent, and (15) The role of the professional broadcaster in educational programs, by Franklin Dunham.

—C.M.P.

SYMPOSIUM. "Trends in Education." *The Phi Delta Kappan* 21 : 369–397; April, 1939.

The following articles constitute this symposium on trends in education: (1) National committees draft educational policies, by William G. Carr, (2) Conservation of American Youth by the National Youth Administration, by Aubrey Williams, (3) Modern trends in educational administration, by George D. Strayer, (4) The conservation of American youth through community youth programs, by Howard M. Bell, (5) Recent trends in financing higher education, by Ernest Victor Hollis, (6) Trends in American finance, by Alfred Dexter Simpson, (7) Current trends in CCC education, by Howard W. Oxley, and (8) An unusual educational opportunity, by Carroll D. Champlin.

Kandel, I. L., Hollingworth, Leta S. and Thorndike, Edward L. How Should a Democratic People Provide for the Selection and Training of Leaders in the Various Walks of Life?" *Advanced School Digest*, 1938.

This is a series of three papers presented at the Fifth Conference On Educational Policies held at Teachers College on November 11, 1938. Kandel presented a paper on Leadership and Education in Other Times and in Other Lands; Hollingworth on What We Know About the Early Selection and Training of Leaders; and Thorndike on How May We Improve the Selection, Training, and Life-Work of Leaders.

—C.M.P.

Orenstein, Lucy. "Examining the Examination." *The Teaching Biologist* 8 : 121–124, 127; May, 1939.

This article describes the use of special type examination questions used by the author in Evander Childs High School. Sample questions are used for illustration.

—C.M.P.

MacDougall, Lois Miller. "How Good Is Your Personality?" *The Instructor* 48 : 14–15; June, 1939.

This is a practical check chart of items by which a teacher may check her own personality. There are nine items: (1) grooming, (2) clothes, (3) personal habits, (4) intellectual traits, (5) general attitudes, (6) personal educational attributes, (7) educational attitudes, (8) social attitudes, and (9) educational methods.

—C.M.P.

Kandel, I. L. "Secondary Education." *The Educational Forum* 3 : 471–487; May, 1939.

This article on secondary education abroad deals with the education of the elite, that is, of those pupils who are likely to profit best by an academic course. Reforms in secondary education recently adopted in France, England, and Germany are discussed at some length.

—C.M.P.

Renner, George T. "Education and the Conservation of Resources." *The Social Frontier* 5 : 203–206; April, 1939.

The following are evidences of waste: (1) soil is depleted or destroyed, (2) forests are cut-over and burned, (3) water resources are wasted or polluted, (4) grasslands are overgrazed, (5) wild life is not protected, (6) minerals are wasted, (7) the flood menace is being augmented, (8) the wrong areas have often been cleared, drained, or irrigated, (9) scenic and recreational resources are being defaced, (10) communities are being allowed to develop along lines unfit for living, (11) human and cultural resources are allowed to deteriorate, and (12) economic production is not equated to social needs.

A successful conservation program would have the following educational objectives: (1) to develop a popular understanding of natural resources, (2) to create geographical habits of thinking, (3) to sensitize the individual to evidences of resource waste, (4) to correct the belief that resources are inexhaustible, (5) to promote the idea of trusteeship in place of ownership, (6) to dispel the idea that science is a substitute for resources, (7) to explode the idea that foreign trade can compensate for exhausted resources, (8) to create a new evaluation of ownership, (9) to build a new social philosophy of rights, and (10) to cultivate a new community ambition.

—C.M.P.

Tead, Ordway. "Charter for a College." *The Social Frontier* 5 : 198–203; April, 1939.

"The purposes of a college, in short, are intellectual, philosophical, spiritual; they are personal and social; they are civic and vocational in the ultimate sense. They are avocational as well. The college points the way to achieving self-realization through social contribution; to forward democratic ends by democratic experiences and convictions. The purposes are to integrate the desires, heighten the insights, increase the sensitivity within persons and thus toward the community; to enhance the sense of the oneness of man with his fellows and with nature; to make clear we cannot help being bound by reciprocal human responsibilities in the nature of things; and to provide the intellectual tools and moral climate out of which structural improvement in organized living can be more rapidly invented and applied in order that all institutions shall contribute more certainly to the good life of each individual. If one sentence could say all of this, we would affirm the purpose of the college as being to help the mind and the spirit to grow in stature and in willingness to function freely and fully."

"Finally, as to curriculum, while the choice of subjects is, up to a point, less important than the manner in which they are taught, our purpose does suggest the desirability of students getting at least a bowing acquaintance with the great, basic, intellectual achievements of the race. Only with such general awareness, plus a moderate intensification in some area congenial to the student's interests, will it be possible for him to come out with the beginnings of a synthetic view of the nature of the world. A convenient, if necessarily artificial, classification of these basic fields of approach is into these four: natural sciences, biological sciences, social sciences, and humanities. The earlier in his college career the student can be aroused to curiosity as to the nature, problems, points of view, and contributions of these four areas, the more assuredly will he be stimulated to probe

further and come to grips with one or two of them in a more penetrating and illuminating way."

—C.M.P.

BARTON, DONALD. "Your Name, Please." *Natural History* 43: 234–235, 237–239; April, 1939.

This interesting article gives the derivation of several first and surnames. They were originally descriptive, and the use of two or more names is not so ancient. The author says that Indian names are much more descriptive and that his own name is "Brown Stranger in the Barley Field"—the name he uses as author of the article.

—C.M.P.

HORWOOD, MURRAY P. "An Evaluation of the Factors Responsible for Public Health Progress in the United States." *Science* 89 : 517–526; June 9, 1939.

One of the striking phenomena of the twentieth century, and to some extent also of the last quarter of the nineteenth century, has been the curtailment of premature mortality, the prevention of disease, and the prolongation of the average life span of man. Since 1880, the general death rate has been diminished more than 50 per cent, and the average expectancy of life at birth has been increased from forty years to approximately sixty-one years. Typhoid fever and diarrhea and enteritis have diminished almost to the vanishing point in many communities; typhus fever and cholera are rarely causes of death in this country today; deaths from diphtheria have been greatly reduced; smallpox is under control in all communities, where vaccination is practiced; the infant death rate has declined more than 175 per cent; the death rate from tuberculosis has been reduced seventy-five to eighty per cent; yellow fever is non-existent; hookworm and malaria are under better control.

—C.M.P.

RUSSELL, BERTRAND. "Education for Democracy." *Journal of National Education Association* 28 : 97–98; April, 1939.

This is the address delivered at the N. E. A. meeting in Cleveland. Education is democracy's chief hope. A teacher should always have a feeling of spontaneous affection toward those he teaches. "This is a person with certain capacities, a person who can do certain things, who has a right to his place in the world."

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New Publications

KARFELD, KURT PETER, (Editor). *My Leica and I.* New York (730 Fifth Avenue): E. Leitz, 204 p.

No camera is better known than the Leica and none is more versatile. While more complicated than some types, the amateur can use it as effectively or even more effectively than some of the cheaper cameras. Pictures can be taken with the Leica that are impossible often with most other cameras. The purpose of this book, both through the textural matter and through the pictures, is to give conclusive evidence that amateur photography can use the Leica most effectively.

The textual material is very practical, informative, and interesting reading. Contributions have been made by various authors. A few of the topics discussed are: (1) travel with the Leica, (2) color photography with the Leica, (3) creative photography, (4) the Leica at night, (5) the Leica at the theater, (6) the Leica for landscapes, (7) plant photography with the Leica, (8) praises and tips, and (9) the Leica for photomicrography.

There are 152 pictures, all taken by amateurs. Technical data concerning each picture is included. Every Leica owner, as well as amateurs and would-be amateurs, will thoroughly enjoy *My Leica and I.*

—C.M.P.

CARPENTER, HARRY A., BAILEY, GUY A. AND BAKER, MARY LOUISE. *Adventures in Science.* Boston: Allyn and Bacon, 1939. 92 p. $0.60.

This is the first book in The Rainbow Series of elementary science readers. There is a monochrome picture on each page. Lessons are arranged seasonally—summer, autumn, winter, and spring. Especial attention has been paid to vocabulary difficulties. The book will appeal to children of the first grade.

—C.M.P.

THIELE, C. L. *The Contribution of Generalization to the Learning of the Addition Facts.* New York: Bureau of Publications, Teachers College, Columbia University, 1938. 84 p. $1.60.

This doctor's dissertation reports an experimental investigation to compare the effectiveness of teaching 100 addition facts to the first half of the second grade by the generalization method and by the drill method. The study was carried out in the Detroit Public Schools, and involved 512 pupils.

A few conclusions from the study are as follows: (1) For the study as a whole, the differences are decidedly in favor of the generalization method, (2) When intelligence ratings are disregarded and comparisons are made on a basis of initial scores, the superiority of the generalization method is a significant one, (3) In the comparisons of the per cents of possible gains, the generalization method results maintain their superiority, and (4) The superior results achieved by the generalization method pupils are in a very large measure due to the fact that they learned the so-called addition facts better than did the drill method pupils.

—C.M.P.

BINGHAM, N. ELDRED. *Teaching Nutrition in Biology Classes.* New York: Bureau of Publications, Teachers College, Columbia University, 1939. 117 p. $1.85.

This experimental investigation of high school biology pupils in their study of the relation of food to physical well-being involved thirteen teachers in eleven cooperating schools. Approximately one thousand pupils participated in the study; complete data was collected on four hundred pupils. The time devoted to the study was thirty periods. Each teacher had the same teaching materials in so far as possible: mimeographed outline, pupil tests, scoring keys, list of reference materials, laboratory animals, and reference books.

Results secured on attitude tests, application of principles tests, and information tests were uniformly encouraging. Pupils, teachers, and parents were enthusiastic about the material and method used in teaching.

This study is a real contribution to progress in science teaching. We need many more similar functional units in all phases of science. Here is concrete evidence that we are making progress, even if slowly.

—C.M.P.

WESSEL, PAUL. *Physics.* Munich, Germany: Ernst Reinhardt Verlag, 1938. 514 p.

This is a German textbook on physics which surely deserves an English translation and publication. The table of contents as indicated from an English translation indicates quite a thorough treatise. Comments from students and professors using the book in the original are most favorable.

—C.M.P.

YATES, HELEN EVA. *The World Is Your Oyster.* New York: Henry Holt and Company, 1939. 296 p. $1.75.

The subtitle, The Art of Traveling Smartly, indicates the content of the book. Hints and tips on traveling wisely, economically, both in this country and over the world in general, make this a valuable book, especially to the novice. When planning that trip you have so long wanted to take, consult this book. It may

make your trip more pleasant, economical, and less annoying.

Some of the chapter headings are: (1) If you can't afford to travel, find a way, (2) How to plan your trip, (3) Popular trips in our own Americas, (4) Around the world, (5) Where to save, (6) For men only, (7) For women only, (8) Saving tips on luggage, (9) Pointers about foreign shopping, (10) Good taste and economy in wardrobe, (11) Questions and answers, and (12) Our World's Fairs.

—C.M.P.

BRIGGS, THOMAS H. *Laboratory Techniques of Teaching.* New York: Bureau of Publications, 1938. 81 p. $0.90.

Contributors to this symposium were members of Dr. Briggs' class during 1937-1938. The result is an unusually good treatise on individualization of instruction. Instruction in this country began with individual instruction and we have a tendency to swing back to this method, now best exemplified in the so-called "progressive" schools. This treatise emphasizes the history and present status of individualized instruction in secondary schools. The many desirable features of laboratory techniques in teaching are pointed out. There is a selected bibliography of 149 titles.

—C.M.P.

FRASIER, GEORGE WILLARD, DOLMAN, HELEN, SHOEMAKER, FRANCIS, AND VANNOY, KATHRYNE.. *The How and Why Club; My Club Book.* Syracuse: The L. W. Singer Company, 1939. 320 p. $1.04; 45 p. $0.24.

This is Book Four of The Scientific Living Series. (The four previous books have been reviewed in Science Education). This book is intended for the fourth grade. It continues the previous monochrome picture series and consists of a series of twenty "how" problems. Examples of these are: How magnetism and electricity work, how animals are classified, how our skeleton is made, how to know the winter constellations, and so on.

My Club Book is an experiment booklet, consisting of 42 experiments for pupils. It correlates with the text, The How and Why Club. This book on experiments is a new departure in elementary science teaching, and would seem to offer some interesting possibilities. A few of the experiments are: I do an experiment, to test for fat, my teeth, dinosaurs, I have found what erosion is, my bird calendar, what magnets do, and so on.

—C.M.P.

SCOTT, K. FRANCES. *A College Course in Hygiene.* New York: The Macmillan Company, 1939. 232 p. $2.50.

The reviewer is very much impressed with the contents and practicality of this combination laboratory-textbook in hygiene. The book is written in an appealing style and there are many excellent illustrations. The first eleven chapters, constituting Part I concern the hygiene of the individual. The next eight chapters, Part II, concerns hygiene of the group. There is a workbook of thirty pages.

College teachers of hygiene and survey courses in biological science, and teachers of health and biology at lower levels wil find the book unusually helpful.

—C.M.P.

PARK, ORLANDO, ALLEE, W. C., AND SHELFORD, V. E. *A Laboratory Introduction to Animal Ecology and Taxonomy.* Chicago: The University of Chicago Press, 1939. 257 p. $2.00.

This laboratory guide has keys prepared with particular reference to fresh-water and terrestrial habitats of the deciduous forest region of North America. This seems to be an unusually good laboratory key for the study and identification of animals. The first twenty-five pages discuss the interrelationship of animals with their environments. There follows a hundred page list of laboratory exercises on terrestrial and fresh-water animals. Then follows a synoptic key to phyla, and key and references to 21 classes and orders. The latter is especially good. There is a glossary, bibliography, taxonomic index, and subject index.

—C.M.P.

DRAFFIN, JASPER OWEN. *The Story of Man's Quest for Water.* Champaign, Illinois: The Garrard Press, 1939. 232 p. $2.25.

No liquid used exceeds water, measured by either amount or value. It is the most important substance used by the chemist, and its everyday and industrial importance are unexcelled. The many references in the Bible attests the importance of water to those people.

This book traces the romantic story of water down to the present gigantic reservoirs of modern cities—from Rome, Athens, Carthage to Chicago, New York, and San Francisco. The most important items of progress in water supply have been the increased use of power to procure water and the purification of water after it has been obtained. Interesting indeed are the methods of securing, transporting, and keeping water. This is an excellent book for the secondary science book shelf.

—C.M.P.

MILLER, DAYTON CLARENCE. *Sparks, Lightning, and Cosmic Rays.* New York: The Macmillan Company, 1939. 192 p. $2.50.

This is an anecdotal history of electricity constituting the 1937 Christmas week lectures for young people given under the auspices of The Franklin Institute. There are three lectures: Sparks, Lightning, and Cosmic Rays. The first two lectures trace the history of electricity, emphasizing the ideas and experi-

ments of Benjamin Franklin. There are 89 figures, most of which are photographs of the actual apparatus used in performing appropriate demonstrations before the audience. One is impressed with the important contributions made by Franklin. This book is one of the best popular treatises on electricity, suitable for the high school youngster, that the reviewer has happened across. It richly deserves a place on every secondary science book shelf. It is also a good reference for the college physical science survey course.

—C.M.P.

FRAPRIE, FRANK R. (Editor). *The American Annual of Photography, 1940.* Boston: American Photographic Publishing Company, 1939. 322 p. $2.25.

This is probably the most complete of all annuals. In addition to the slightly less than a hundred well-selected photographs from the best pictures of 1939, there are numerous illustrated articles by leading authorities in photography. The illustrations are each discussed somewhat at length, both technically and pictorially.

Some of the leading articles are: (1) photography goes forward, (2) photographic permanence, (3) enhancing your print quality, (4) pictorial photography and the snapshot idea, (5) photographic speed ratings, (6) modern synchroflash photography, (7) tone composition, (8) a home-made highpower telephoto lens, (9) determining shutter speeds, (10) texture, and (11) American Annual formulary. This latter includes many excellent formulae.

—C.M.P.

FEININGER, ANDREAS. *New Paths in Photography.* Boston: American Photographic Publishing Company, 1939. 63 p. $2.75.

This book might as well have been entitled *Creative Photography*, for it is just that. It emphasizes the graphic qualities. The forty-seven plates illustrate the five different methods employed: (1) direct projection, (2) negative print, (3) negative-on-diapositive, (4) granulation, and (5) solarization. This book will prove interesting and useful to all advanced students in photography, others who strive to obtain unusual effects, and to teachers of courses in photography.

—C.M.P.

FEATHERSTONHAUGH, DUANE. *Press Photography with the Miniature Camera.* Boston: American Photographic Publishing Company, 1939. 159 p. $2.00.

The author is a well-known press photographer of many years' experience, so he is able to bring specific, practical methods into his discussions. The book is intended for those who would like to use some of their spare time taking pictures that will sell to the press.

The author evaluates equipment; emphasizes the use and versatility of the miniature; the kind of pictures that sell; the technique, psychology, and ethics of taking pictures; probable markets and profitable sidelines, and clever approaches to them.

Users of all cameras, whether interested in sales or not, will enjoy reading this book.

—C.M.P.

MORTENSEN, WILLIAM. *Print Finishing.* San Francisco: Camera Craft Publishing Company, 1938. 127 p. $2.60.

The author is one of America's best known pictorial photographers. He is especially known for his unusual skill in finishing prints. In this book he tells how he does it. Anyone who does his own printing and developing, or who would like to do so, will find this book valuable.

Among the topics discussed are: (1) printing papers, (2) drying, (3) flattening the print, (4) use of the powder tone, (5) use of the carbon pencil, (6) use of the blade, (7) use of the spotting brush, (8) trimming and cropping, (9) mounting, and (10) framing.

—C.M.P.

JORDAN, STANLEY R. *Modern Portraiture.* San Francisco: Camera Craft Publishing Company, 1938. 199 p. $3.00.

In *Modern Portraiture* the author introduces the technical methods of Hollywood's movieland to still portraiture. Seemingly his efforts have been most successful. The content of this book can best be judged by noting the chapter headings: (1) the studio, (2) equipment, (3) principles of lighting, (4) exposure and development, (5) preparation for a portrait, (6) make-up, (7) posing, (8) portraits of women, (9) portraits of men, (10) portraits of children, (11) Hollywood portraits, (12) outdoor portraits, (13) home portraiture, and (14) portrait photography as a business.

—C.M.P.

BAILEY, HILLARY G. *The Story of a Face.* San Francisco: Camera Craft Publishing Company, 1938. 127 p. $2.50.

This book on portraiture does not duplicate *Modern Portraiture*, reviewed elsewhere. Rather the two books supplement each other. Included in this treatise is some history and philosophy of photography and considerable theory and practical information relating to light, lenses, lines, and symmetry. Numerous illustrations add much to the usefulness of the book.

—C.M.P.

GOLDNER, C. A. *Commercial Photography with the Miniature Camera.* San Francisco: Camera Craft Publishing Company, 1939. 95 p. $1.00.

This interesting little booklet offers much valuable advice and information to the amateur photographer who is using a miniature camera,

and to all who would like to make some spare money selling some of their pictures. Topics discussed are: (1) the miniature camera, (2) where to look for business, (3) how to get started, (4) serving the local merchant, (5) legal, accident, and insurance work, (6) the real estate market, (7) profitable sidelines, (8) natural color photography, and (9) successful miniature camera technique.

—C.M.P.

HEERING, WALTHER. *The Rollei Book.* New York: Burleigh Brooks, Inc. 128 p. $2.00.

While the material in this book refers specifically to the Rollei camera, most of the advice and information is applicable to all cameras. It is the type of book that all amateurs will welcome. The discussions are unusually free from technicalities. Such topics as using the camera, accessories, color filters, exposure time, developing, printing, and enlarging are discussed.

—C.M.P.

HEERING, WALTHER. *Night Photography.* New York: Burleigh Brooks, Inc. 54 p. $1.00.

The first twenty-three pages are devoted to various aspects of time exposure—the primary difficulty in night photography. The second part discusses snapshots at night, fireworks, flashlight photographs, and infra-red.

—C.M.P.

WINDISCH, HANS. *An Encyclopaedia of Modern Photography.* New York: Burleigh Brooks, Inc., 1938. 268 p.

This is an excellent, brief encyclopaedia covering all phases of the photographic process—types and sizes of cameras, light and color, film and filter, enlargement, lenses, artificial light, common faults, and color guide. The color guide is exceptionally good. There is also a brief photographic dictionary, historical data tables, and formulae. This will prove a most valuable book for everyone using it.

—C.M.P.

SEARS, PAUL B. *This Is Our World.* Norman, Okla.: University of Oklahoma Press, 1937. 292 p. $2.50.

This is a far-seeing book, the story of man and the world he lives in, of the laws to which all living things are subject, and of the relation of living things to the surrounding physical world. The aim is to make "the realities of man and his environment . . . plain to the average man so that he may see what his leaders (in our democracy) are about." The book is illustrated with poignantly clever pen drawings by the author. It is a powerful book in simple language, and one welcomed by the conservationist particularly. It should be put into the hands of high school and college students, as well as into the hands of the layman.

—L.M.S.

EAKLE, ARTHUR S. *Mineral Tables.* Third Edition, revised by Adolf Pabst. New York: John Wiley and Sons, Inc., 1938. 73 p. $1.50.

These tables describe about two hundred minerals by their physical properties, arranging them primarily by their streak, color, and hardness, thus giving the student the surest and quickest means of identifying minerals. The table gives name of mineral, then tabulated data on composition, color, streak, luster, hardness, system, cleavage or fracture, specific gravity, common structure, and observations.

—L.M.S.

RENKEL, R. A. *Workbook for Elementary Agriculture.* New York: American Book Company, 1938. 106 p. $0.48.

The workbook is divided into fifteen units, allowing flexibility in the order of study of units. Although written primarily to accompany either of two particular basal texts, references to relevant chapters in some twelve supplementary texts are given at the beginning of each unit, which makes the workbook very usable. An appendix tells how to obtain agricultural literature, gives visual aids for teaching agriculture, a teacher's reference list and score cards for cattle, hogs, horses, and sheep. Objective tests for each unit to be taken by the teacher and administered at the proper time, are included in a sheaf at the back of the workbook. The back cover of the workbook contains a chart for recording the pupil's score on each test.

—L.M.S.

BRAUER, OSCAR L. *Exploring the Wonders of Chemistry.* New York: American Book Company, 1938. 246 p. $0.48.

This is a book of experiments in chemistry to teach the high school student to observe, recognize and understand chemical facts and processes as he meets them daily, at home, in the field, in city, garage, or bakery. The number and variety of experiments is such that they fit various types of courses from college preparatory to so-called practical courses for the study of those who will take no more chemistry. The experiments which should be included in a college preparatory course are starred.

In addition to the usual type of exercise there are chemical projects, experiments at home and chemical-fun experiments intended to stimulate interest in chemistry outside the school laboratory. Practice exercises are given as a teaching aid. Prepared tests for mid-semester and semester examinations are inserted at the back of the workbook, with the suggestion that the teacher remove them and administer them at the proper times.

An appendix gives directions for mixing the solutions needed for the laboratory experiments, lists of chemicals and other supplies needed.

—L.M.S.

VERRILL, A. HYATT. *Strange Birds and Their Stories.* Boston: L. C. Page and Company, 1938. 203 p. $2.50.

The author endeavors "to describe the unusual, little known, and oftentimes astonishing lives and habits of certain birds of our own country and of distant lands." Twenty chapters of material on migration, bird colors, nesting habits, bird law courts, valuable birds, flightless birds, bird communists, birds with four feet, bird pugilists, strange partners, feathered dancers—these classifications and still others make fascinating reading. The book is illustrated with a number of full page plates in color and in black and white, also with pen drawings of individual birds. Junior and senior high school students, students of college biology and the layman will enjoy the book and find it stimulating to an interest in birds.

—L.M.S.

RICHARDS, HORACE G. *Animals of the Seashore.* Boston: Bruce Humphries, Inc., 1938. 273 p. $3.00.

This is a very usable book for the layman, for the teacher, and for the student of science in high-school and college biology. It treats of the sea animals of the Virginian zone of the United States, a zone of the Atlantic Coast lying between Cape Cod and Cape Hatteras. Most of the animals described were obtained from the coast of New Jersey, which gives the book a particular value to teachers in New Jersey schools. From the Porifera to the lower Chordata the book treats of each phylum and the individuals within it, illustrating the text with photographs and drawings. A glossary and a good bibliography are included.

—L.M.S.

MORRIS, PERCY A. *Nature Photography Around the Year.* New York: D. Appleton-Century Company, 1938. 251 p. $4.00.

This is a unique book, instructing the nature photographer in what is available to photograph month by month and how to photograph natural things.

A general chapter on equipment and procedure is followed by twelve chapters, one for each month of the year. The book serves a twofold purpose, first to help the nature lover who has had no experience with a camera, second to help the experienced photographer who has had little training in nature study.

Good suggestions are given for lighting many subjects. In connection with the discussion of microphotography, a diagram of the apparatus set up would be useful. Mention should also be made of the possibility of using the microscope focussed as for visual observation and photographing with the camera focussed for infinity.

The text is accompanied by illustrations, excellent in general. In some cases one might wish for additional contrast between the subject and the background and a greater sharpness of detail.

Mr. Morris is a member of the technical staff of the Peabody Museum of Natural History of Yale University, adviser on amphibia and reptiles to the Visual Education Service, and President of the New Haven Bird Club. As a collector over many years from Pennsylvania to Newfoundland and one with much experience in photography, Mr. Morris is highly qualified to write such a book.

—L.M.S.

WATSON, E. L. GRANT. *Mysteries of Natural History.* New York: Frederick A. Stokes Company, 1936. 244 p. $1.75.

This book, first published in England under the title of *Enigmas of Natural History,* contains 24 episodes from the life histories of animals. Most of these have been chosen as presenting cases of complicated adaptation and the author seeks to indicate that the animals have become what they are as the result of "inherent final causes" rather than through either adaptation of environment or through the action of natural selection.

The author shows himself to be a keen and careful observer of nature. He has written his stories of animal life both in Europe and Australia from personal observation and from material published in scientific journals not easily accessible.

The book will be enjoyed by children of the junior and senior high schools, by college students, teachers and the layman. Numerous wood-engravings by Barbara Greg admirably supplement the text, showing each character in its environment. The style of the text is simple, the material fascinating and the bit of speculation indulged in by the author provocative to thought by the reader as well.

—L.M.S.

HICKS, AMI MALI AND OGLESBY, CATHARINE. *Color in Action.* New York: Funk and Wagnalls Company, 1937. 259 p. $3.00.

"This book aims, not to teach art, but to show how the use of color may become an art through organic association with dress, interior or exterior decoration, and with all else where we feel its need." The book gives a practical interpretation of color which will be of service to many; such as, the interior decorator, the textile designer, the designer of stage costumes and sets, the teacher of painting and design, the student of color. The color photographer will find help in this book as well. The book is very readable.

—L.M.S.

MAYER, JOSEPHINE AND PRIDEAUX, TOM. *Never to Die.* New York: The Viking Press, 1938. 224 p. $3.50.

This is a beautiful book and is an attempt to present for probably the first time "the Egyptians in their own words" in close relation to the life

of the people, their art, and their history. Selections have been made from the literature of the Egyptians from about 3000–1000 B.C. The selections are uncluttered by footnotes, but a list of sources indicating adaptations and reductions heads the bibliography. The Egyptian art which illustrates the text has for the most part been placed in chronological order, coupled with the writing of its period. Historical introductions are given at the beginning of each section. Chronological indexes fix the sections in relation to dynasties, particular kings, and significant events among neighboring groups. Most of the line-drawings have been taken from reliefs decorating the walls of tombs and temples. The authors have sought to create an interest in the Egyptian himself.

The authors are teachers of history and literature in the Lincoln School and Teachers College, Columbia University. The book is fraught with interest for the student of history, of art, of science, and of literature.

—L.M.S.

CASTERET, NORBERT. *Ten Years Under the Earth.* Translated by Barrows Mussey. New York: The Greystone Press, 1938. 283 p. $3.00.

The life of a speleologist is one of adventure and risk, but thrilling and satisfying to one who is resourceful enough to safely overcome almost unsurmountable obstacles. *Ten Years Under the Earth* is fascinating reading for one interested in natural wonders. It describes the efforts of one of the worlds foremost speleologists in his conquest of the caves and caverns of France. The book is illustrated with 58 halftones, many of them full size pages.

—W.G.W.

COLLINS, A. FREDERICK. *The Radio Amateur's Handbook.* New York: Thomas Y. Crowell Company, 1939. 419 p. $2.00.

This book gives a clear and simple explanation of the devices and processes used in radio up to its present date. This (1939) is the ninth printing of the last edition (1933), and in the rapidly changing radio industry can not bring the readers a very clear picture of radio in its present stage of development. However, it does have a wealth of radio information that cannot have become entirely out of date. There are more than 100 illustrations, a glossary and an appendix of useful information.

—W.G.W.

FROST, GEORGE E. *Planets, Stars and Atoms.* Caldwell, Idaho: The Claxton Printers, Ltd., 1939. 287 p. $3.00.

This very readable book was written for teachers in elementary schools. It will serve well as a reference book for pupils in high school, and we recommend it to the general reader interested in natural science. It gives a view of the advances of science in the limited fields noted in the title. It is illustrated with 34 halftones and diagrams, and 8 star maps.

—W.G.W.

RICHARDSON, E. G. *Physical Science in Modern Life.* New York: D. Van Nostrand, Inc., 1939. 256 p. $3.00.

Recent advances in physical science and their contacts with everyday existence sum up the content of this book. Much unusual information is given, possibly less familiar to us because of its English origin. It treats: Streams and Eddies, Vibrations and Waves, Sound Waves, Supersound, Colloids, Heat, Light, Electricity, Sensation, Reaction and the Exploration of the Stratosphere. There are 16 halftone plates and 60 line drawings.

—W.G.W.

HAUSMANN, E. E. AND SLACK, E. P. *Physics.* New York: D. Van Nostrand, 1939. 756 p. $4.00.

This college text is written particularly for those who will be majoring in science, technology or engineering. It has cultural value but rather too technical and too mathematical for the average college student who is not particularly interested in science. Certain advance topics are starred for omission for shorter courses. The book offers very complete and thorough treatment of mechanics, heat, electricity, and magnetism, sound, and light. There are over 800 problems for solution. The book is illustrated with 471 figures, most of which are line cuts.

—W.G.W.

HENRICI, ARTHUR T. *The Biography of Bacteria.* Boston: D. C. Heath and Company, 1939. 494 p. $3.60.

The book opens with an interesting chapter on the history of bacteriology which is followed by a chapter describing historic microscopes and the various types used in our modern laboratory practice. The remainder of the book covers the various types of microscopic life. It is a comprehensive work, and yet not too voluminous for a one-semester course for the general college student. It stresses the pure science aspects rather than the applications which are in most cases rather obvious. There are 110 illustrations.

—W.G.W.

ROBEY, WILLIAM H., Editor. *Health at Fifty.* Cambridge: Harvard University Press, 1939. 299 p. $3.00.

Twelve aspects of health at fifty years of age or thereabouts are discussed by as many different authors, each of whom has had special experience and preparation in the particular field. Heart disease, blood pressure, obesity, cancer, rheumatism, eye care, vitamins, glands, and mental health are among the subjects discussed. The book is especially valuable to the layman who is unread in medical literature. In addition it is up to date

for the usual reader in some of the newer aspects engaging current interest such as vitamins, and social stress and mental health. It is necessarily not exhaustive anywhere. It merely suggests, in its emphasis, phases of health which should receive definite attention by persons nearing the decline of physical or mental powers and presents the rationale for the suggestions implied with a background of factual knowledge in each field.

—A.W.H.

PRICE, A. GRENFELL. *White Settlers in the Tropics.* New York: American Geographical Society, 1939. 311 p. $4.00.

A very excellent compilation of historical, physiographic and climatic information regarding tropical regions the whites have attempted to settle. It is an invaluable handbook for the administrator of the tropical possessions of temperate countries and for any one who contemplates moving to the less crowded tropical regions. Citizens of the United States may well read it to get an understanding of the problems that confront its people in the tropical portions. The facts stated are related in an interesting and impressive way. Whites of the temperate zones can live healthfully, rear families and work hard in the tropics provided they will conform to now well known rules regarding housing, sanitation, clothing and diet. The real problems are social and economic and arise from contact and competition with tropical peoples well satisfield with low standards of living.

—E.R.D.

BAITSELL, G. A., Editor. *Science in Progress.* New Haven: Yale University Press, 1939. 322 p. $4.00.

A series of ten National Sigma Xi lectures by men who are working at the very front of scientific research: E. O. Lawrence on The Latest in Atoms; H. C. Urey on Isotopes; W. M. Stanley and L. O. Kunkel on Virus and Virus Diseases; K. E. Mason on Vitamins and Hormones; R. R. Williams on Thiamin; Edgar Allen on Internal Secretions in Reproduction; T. S. Painter on Minute Structure of Chromosomes; E. N. Harvey on Electric Potentials of the Human Brain; F. G. Benedict, Metabolism from Mouse to Elephant. The lectures are clear but not milk for babes. It is a book well worth buying and studying, if you want to know what such researchers are doing and thinking about.

—E.R.D.

BEARD, MIRIAM. *A translation of Grete de Francesco's The Power of the Charlatan.* New Haven: Yale University Press, 1939. 288 p. $3.75.

The original was recently published in Switzerland. To it Miriam Beard has made additions on American quackery. Charlatans are defined as men "who with a superfluity of artificial words, with boasting and deception, endeavor to pass the false for the genuine and turn the credulity of their fellow men to profit." Part III, Power Through Propaganda, is timely just now.

The book relates the accomplishments of some of the famous charlatans. One marvels that mankind has been so readily duped until he realizes that the same sort of thing is going on right now. Part V, The Marvels of Technology, a New Form of Magic will particularly interest the scientist. The whole book is interesting as a study in the psychology of deception. It does not add to your respect for Homo sapiens.

—E.R.D.

MELDRUM, WILLIAM BUELL; FLOSDORF, EARL WILLIAM; DAGGETT, ALBERT FREDERICK. *Semimicro Qualitative Analysis of Inorganic Materials.* New York: American Book Company, 1939. 354 p. $2.75.

A text and manual for a college course for students with at least, a background of elementary chemistry. The analytical scheme is quite orthodox with the use of not too many organic reagents as confirmatory tests. The first 160 pages of the book deal with the fundamental principles involved in qualitative analysis including the newer concepts interspersed with numerous examples, equations, and problems or exercises. Part II of 117 pages includes the laboratory instructions, experiment directions, and directions and outlines for the systematic analysis of 26 cations and 15 anions. The general directions for the laboratory are carefully given and if followed will lead to good analytical technic. One of the outstanding features of this part is the list of recommendations as to the method of keeping the laboratory record. Part III of 45 pages deals with the reactions of the cations and anions most commonly met with in qualitative analysis and which are typical of the general properties of the ions. In most cases the equations for the reactions are given in ionic form. Where authorities differ as to the equations which represent certain reactions the authors aim to give the student a plausible and reasonable explanation, even though imperfect, so that he is provided with a working tool to carry on.

Part IV is the Appendix and includes reference tables, solubility data, flame colors, reagents used, their concentration and methods of preparing their solutions. Other information such as preparation of special reagents, information concerning the hydrogen sulfide supply, etc., is also included.

J. Austin Burrows.

PACKARD, F. R., COHN, A. E., MARTLAND, H. S., WALSH, J. J., PEARL, R., BURBANK, R., and COLE, L. G. *Landmarks in Medicine, the Laity Lectures of the New York Academy of Medicine.* D. Appleton-Century Company, 1939. 347 p. $2.00.

Three of the lectures deal with the history of medicine. One might better read Garrison or other standard history. Maitland's lecture is a forceful plea for the abolition of the coroner and

the appointment of a medical examiner in his place. It describes the work of this officer in New York City. If you would live long select long-lived ancestors and take life at an unhurried pace is Pearl's advice in his Search for Longevity. Cole's recollections of the applications of the X-ray in medicine is good source material for medical history.

—E. R. D.

CRAWFORD, CLAUDE G. *How to Teach.* Los Angeles: Southern California School Book Depository, 1938. 511 p. $2.50.

In the preface, the author, Professor of Education at the University of Southern California, says "It doesn't say the final word on the subject—I haven't made very much effort to use a dignified and conservative literary style because I have been writing to the collegiate crowd instead of the professors. It has been used in lecture form for about sixty such class groups, and very few students ever went to sleep in class." The text is intended for upper grade and secondary teachers. To the reviewer it would seem to be a most interesting, appealing book to the student and is unusually good in its emphasis on practical, concrete classroom situations.

The chapter headings are: (1) Getting a teaching position, (2) Organizing the classroom routine, (3) Developing teacher-pupil harmony, (4) Controlling pupil behavior, (5) Motivating school work, (6) Improving study habits, (7) Planning courses, (8) Planning lessions, (9) Making assignments, (10) Informational teaching, (11) Skill teaching, (12) Problem teaching, (13) Developing convictions, (14) Appreciation teaching, (15) Asking questions, (16) Lecturing and telling, (17) Using textbooks, (18) Using the library, (19) Concrete teaching, (20) Laboratory teaching, (21) Socialization, (22) Project teaching, (23) Making education function, (24) Making individual adaptations, (25) Classroom testing, (26) Issuing marks and (27) Winning Professional advancement.

—C.M.P.

WRINKLE, WILLIAM L. *The New High School in the Making.* New York: American Book Company, 1938. 318 p. $2.50.

When the history of important movements and developments in secondary education of the present era are matters of record, there are many who believe that the outstanding contributions in secondary thought and practices will have been made by the members of the staff of the secondary school of the Colorado State Education. Since 1932 this school has been involved in a program of modernization of high school thought and practices that its members believe is destined to well nigh revolutionize the secondary school world. This revolution involves philosophy, methods and content in subject matter and related fields, marking systems and evaluation techniques. Already these have been widely copied by many other secondary schools. The Colorado school may be the answer as to what will happen to the present average conventional, superficial, monotonous programmed and more monotonously-taught high schools of today.

The philosophy, basic ideas, guidance program, reporting and marking system are presented in this treatise. Specific fields such as social studies, art, mathematics and science are covered by the specialists teaching in these fields.

Science teachers should especially read the chapter on science—A program based on pupil interest, involving problem-solving techniques as a method, and evaluating the program in terms of the thinking skills developed.

—C.M.P.

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